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WITH OUR OWN HANDS

RESEARCH FOR THIRD WORLD DEVELOPMENT: CANADA'S CONTRIBUTION THROUGH THE INTERNATIONAL DEVELOPMENT RESEARCH CENTRE 1970–1985

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Introductory Chapter by Hugh Wynne-Edwards

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CONTENTS

Preface **5**

1 Introduction and Critical Review **7**

2 The Role of Research in Third World Development **15**

3 IDRC and Third World Researchers: The Products of Partnership **27**

4 The Kenya Ceramic *Jiko* **63**

5 Animal Production Systems in Central America **77**

6 Primary-School Teachers in Egypt **89**

7 Rural Sanitation in Sierra Leone **103**

8 Rural Aquaculture in India **125**

9 Oral Rehydration Therapy in the Philippines **133**

10 Jamaica's National Information System **143**

11 Cropping Systems Research in Indonesia **157**

12 Fuelwood and Polewood in Malawi **173**

13 Storing Seed Potatoes in Peru **187**

Appendix — Acronyms and abbreviations **203**

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The preparation of this publication has been very much in keeping with IDRC's philosophy of operating in partnership with people of developing countries. Much of the work was carried out by individuals from the Third World: eight of the case studies were researched by people from Latin America, Africa, the Middle East, and Asia; two were written by Canadians with substantial help from people in Jamaica and Sierra Leone; the basic research and writing of chapters 2 and 3 were done by Frank Campbell, a journalist and diplomat from Guyana. Individual acknowledgments appear on the title page of each chapter. George Sanderson of Ottawa made an invaluable contribution to rewriting and editing. Within IDRC, a major team effort was involved, with all divisions, regional offices, and areas of staff expertise, from peer review to word processing, providing input. Overall coordination has been the responsibility of John D.M. Hardie of the Office of Planning and Evaluation.

PREFACE

Evaluation is one of the most complex and elusive challenges in the process of development, yet it is absolutely vital if we are to improve those processes. Among the many approaches to evaluation, I find great value in the concept of "impact" because it is likely to provide the most meaningful focus of all such studies. The word itself has a useful and cautionary double edge to it: organized development is by definition a disturbance and the crucial question is whether the disturbance generates the desired positive impact — of self-reliant enhancement of the quality of life — with the minimum of negative impact.

It was, therefore, with special pleasure that I learned that IDRC was embarking upon a series of impact studies related to projects supported by the Centre. I was the more impressed — although not surprised because this is a hallmark of the IDRC — that 8 of the 10 studies were carried out by specialists of developing countries. The emphasis of the Centre on building the development research capacities of developing countries themselves has helped to fill a very serious gap that grew in the years when there was far too much extractive research in developing countries by scholars from industrialized countries, well intentioned but too often resulting in knowledge built up only in the North.

From a dynamic international organization given to the development community by Canada, these studies should not only be of great value to its own future work, but also offer lessons in design and other techniques that all of us can use. By definition, there is no perfect model for a development process. It is, therefore, of utmost importance that as we *do*, we ensure that we *learn* — from error as well as success — so as to do better by the peoples of the developing countries.

Bradford Morse
Administrator
United Nations Development Programme

CHAPTER ONE

INTRODUCTION AND CRITICAL REVIEW*

This book reviews the 15-year history of a unique agency for international development that was set up in Canada in 1970. Established by the Canadian Parliament at the time when public debate on the "Just Society" was at its peak, the International Development Research Centre was granted an extraordinary measure of independence from the political process, from many of the strictures of government bureaucracy, and from the need to tie its assistance to domestic sources. It was also endowed with a genuinely international character in the sense that its resources could be — and virtually all would be — expended in developing countries for their benefit. Also, among development bodies, only IDRC has a sovereign and completely international Board of Governors. This board comprises a chairman and president and up to 19 other Governors, of whom 10 are not Canadian: six are from the Third World and four from other donor nations. Fifteen years later, the agency is still unique — admired and emulated but not replicated in other countries.

At the inaugural meeting of the Board on 26 October 1970, the President, W. David Hopper (1970), stated that IDRC had decided to focus on

> the welfare of peoples, both farm and non-farm living in rural areas throughout the world, [realizing that] the quest for the welfare of rural peoples will challenge fully our capabilities and our budget.... The whole space of rural life would hold our attention: education, nutrition, local government and administration, social institutions, the measures necessary to protect and preserve the rural environment, and the physical health of the rural family....

Again and again, IDRC has confirmed its purpose and its dedication

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**This chapter was written by Dr Hugh Wynne-Edwards, FRSC, Vice President Research and Development and Chief Scientific Officer of Alcan International Ltd., Montreal, Quebec.*

to the rural economy. In mid-1985, Ivan L. Head, the President of the Centre, stated to a Parliamentary committee that

> successive Boards have insisted that research supported by the Centre be of a practical, applied kind, that it be for the poorest segment of the population, that projects be proposed by developing country scientists and the research be managed and conducted by them so that the benefits remain within the developing country itself.

This steadfast focus on development as a process for the benefit of the rural poor, coupled with IDRC's independence, has determined the nature and scope of the activities reported in the following chapters.

This volume has two parts, an extended introduction about development research and IDRC in general terms (chapters 2 and 3) and a series of case studies prepared mostly by participants in the host countries involved (chapters 4–13). The introduction examines the need for and the role of research in Third World development and the response by IDRC along three main directions — the enhancement of research capacity in developing countries, the production of answers to specific and pressing questions, and the forging of networks and links among researchers and others involved. The latter is to help overcome the intellectual isolation of the highly trained Third World person, whose nearest peer can be hundreds or thousands of miles away. The second part, where individual cases are reviewed, offers a tiny, but compelling, glimpse of the scale, complexity, and benefits of the work in hand. Tiny, because only 10 projects are reported among the hundreds underway in any given year, and compelling because the sensitivity, cooperation, and persistence required for any success are so well revealed.

IDRC is the antithesis of the large aid agency; its projects are small, yet the impact of a few tens or a few hundreds of thousands of dollars can be very large. It does not seek to deliver technology in packages, nor in megaprojects, but instead to develop indigenous technologies at the point of maximum impact and usefulness.

This report is a work of unusual importance. As an outsider and newcomer to IDRC's activities, I find it can be read at two levels. At the first level, the report is full of good news. It makes an unassailable case for a history of practical and steady progress with IDRC's mission "to stimulate and support scientific and technical research by developing countries for their own benefit" (IDRC 1984:1). At a second and more abstract level, the report offers lessons to be derived from this history regarding the process of technical development itself. These lessons are profound. They have implications of importance not only for Third World countries, but also for Canada and other countries of the North struggling with technological changes that affect their own economic and social development.

International development is, by definition, about change. It necessarily involves innovation, which is the process of delivering to people the knowledge generated by research in a form that has useful and enduring benefits in practical economic or social terms. Anyone who has spent time, no matter where, wrestling with this delivery process knows fully how intricate and difficult it is. Success cannot be claimed until a long sequence of careful steps is complete. With IDRC's focus on development for the benefit of people in ultimate need, the critical importance of establishing early cooperation and understanding between the transmitter of information and its eventual user becomes starkly clear.

In corporate terms — and IDRC is a public corporation — the "market" for the enterprise is the world's poor, and the "product" is the creation, adaptation, and implantation of technology to "accelerate the blurring of the line between deep poverty and towering affluence that now separates the mass of mankind from the few" (Hopper 1970). In IDRC's case, the surrogate for "profit" is in people being better off. To be successful, any enterprise has to reach and satisfy its market. It is just that the more familiar type of corporation, having its market apparently at hand and accessible, may readily and repeatedly overlook the paramount importance of preparing the ground for innovation by direct and intricate involvement with the eventual customer. If the first lesson of successful innovation is involvement with the market, then the second is the appropriateness of the product itself for the uses intended. Again, the cases reported are replete with examples.

Necessarily, the projects reported here deal with the fundamentals of existence. They address the physiological and survival needs of people — the lowest rung of Maslow's hierarchy. In order of primal urgency, they deal with food (chapters 5, 8, 11, and 13), fire and shelter (4 and 12), health (7 and 9), and education and communication (6 and 10). Where needs as basic as these are not already being met, no infrastructure can be taken for granted. It is this fact that makes the experiences related so illuminating regarding the requirements for successful innovation anywhere. Remarkably, this learning function was part of the primary objective of IDRC from the very beginning. The Act of Parliament creating the Centre (Government of Canada 1970) defined its corporate object as being "to initiate, encourage, support and conduct research into the problems of the developing regions of the world *and into the means for applying and adapting* scientific, technical and other knowledge to the economic and social advancement of those regions..." (the emphasis is mine). There was to be not just research for development, but equally research on the development process. I think that IDRC's success with the latter is clearly discernible at the second, more abstract, level of reading of this volume.

My personal understanding of the development process grew considerably with the construction of Fig. 1. It depicts the activities of innovation as sequential steps in a staircase from existing technology at the base to creative invention at the top. The sequence was evolved by a committee to which I belong (Industrial Sector Liaison Group to the United Nations Conference on Science and Technology for Development [UNCSTD] [May 1982]) consisting of representatives of large multinational corporations, drawing on their long experiences to interact with the United Nations on issues of technology transfer and industrial research. The key point of the staircase is that each step provides an indispensable infrastructure for the one above. The infrastructure is all about confident and experienced technology management. Unless the

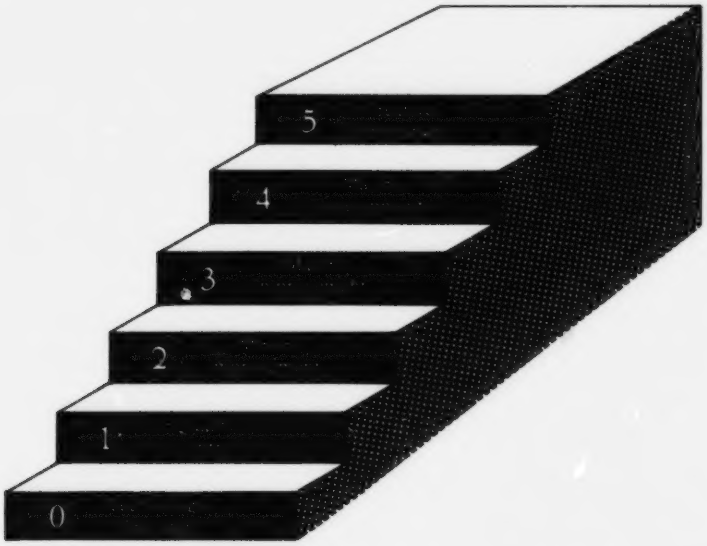

Fig. 1. The innovation staircase: levels of science and technology.

staircase is complete, creative invention can seldom find a useful outlet — innovation cannot follow from invention in terms of realizing practical economic or social benefit.

Similarly, each succeeding step must be grown from the confidence developed at the level below. For example, the building of a plant in a new place is an act of technology transfer (step 0). As management confidence within that plant grows, a local ability develops to maintain it well and look after the quality of its product (step 1). With this experience comes the confidence to make minor improvements (step 2), and then more major ones (step 3). Only long management experience, however, leads to successful radical change in terms of a major development (step 4) that may change the technology entirely and even render it obsolete. Finally, success with such major developments provides the social, economic, and institutional infrastructure necessary to make use of entirely new inventions (step 5). Without them, the invention will languish, unless it is picked up by a country in which the staircase of innovation management is complete.

Sadly and inevitably, therefore, any socioeconomic development arising from basic research (the focal activity of step 5) will belong to those countries whose infrastructure for innovation is in place. The evidence is growing in the newly industrialized countries that rapid progress up the staircase can be made once its base is secure. Indeed, the interdependence of the world's economies has never been clearer as the growing productivity of these countries challenges the established, affluent economies.

This bottom-up view of the driving force for successfully applied research runs counter to a more popular version in which the process starts with creative research (usually university-based) and flows through to practical technology in the marketplace. This does happen, of course, but only as a counterflow to the natural evolution and maintenance of an innovation staircase already in place. Upward step by upward step, it forms the indispensable technical infrastructure that becomes more developed and diverse in terms of communications, services and supplies, and the educational and skill levels of those involved in the practical application of results.

Inevitably, therefore, the technical steps correlate broadly with socioeconomic benefit. The committee that studied the issue found from its own experiences a good general correlation between the level of technical activity that was economically successful in a country and the economic status of that country as a whole in terms of per-capita income.

There are numerous individual anomalies due to other factors. Canada is one. As a result of its raw material wealth and ready access to the United States' market, Canada has reached high levels of per-capita income with a technology infrastructure in its industries (with a few exceptions) that is truncated somewhere between step 2 and step 3. According to one set of indicators, Canada ranks among 17 developed countries: 1st in freedom, 4th in education, and 15th in productivity, a signal that the high level of national education has been invested in activities largely unrelated to the creation of economic wealth.

Countries such as Germany and Great Britain have been beneficially at the top of the staircase of innovation for several hundred years. The printing press in Germany and the spinning jenny in Britain are early examples. The United States joined them about the turn of the century with Edison, Bell, and the Wright Brothers. Japan, most obviously, has resolutely climbed that staircase since World War II and has announced its latest challenge, the fifth generation computer as the symbol of step 5, in this decade. Britain, where the industrial revolution brought world dominance and the wealth of empire, has now deindustrialized to a point where the technical infrastructure has decayed and largely eroded, leaving, as in Canada, a highly educated population with a capacity for invention that can find few outlets in the domestic economy. This is a vulnerable position in the face of the present restructuring of developed world economies around areas of new technology.

There are tangible social and economic benefits at each step of the staircase, built by successive investments to improve and extend what already exists. This natural sequence is exactly the pattern of IDRC's activity, which shows again and again the startling improvements that can follow from beginning with what is already in place.

Chapter 13, the last chapter, provides ideal illustrations. The subject is potatoes, a crop produced in 130 countries inhabited by 75% of the world's population. The practices for growing and handling potatoes have evolved over hundreds and thousands of years. There are substantial risks in changing techniques that have been evolved so painstakingly to meet local conditions, even though these practices are not optimal. This specific project involved a grant from IDRC to the International Potato Centre (CIP) in Peru for agroeconomic research.

Initially, an interdisciplinary team had gone out, focused on delivering three-pronged packages of existing technology (improved seed, fertilization, and pest control) that could be used to maximize potato productivity. Although the farmers showed an interest in the program and began applying some of the low-cost practices selectively, the effort failed in on-farm trials and demonstrated that there was little technology that could be transferred directly to farmers without local adaptation. It also showed that the farmers were themselves active researchers and developers in their own right — intervening, adapting, and choosing.

The work of another interdisciplinary team was focused on postharvest problems. This team set out to develop simple storage and process technologies appropriate to existing local conditions. The objective was to reduce storage losses due to rotting, insect attack, shrinkage, and sprouting. It soon became evident that what appeared as "losses" to the research team appeared as different forms of use to the farm family, which threw nothing away in the farm economy. Progress was difficult, until the farmers, the biologists, and the social scientists found common ground on the need to improve storage for seed potatoes rather than for potatoes in general. Seed potatoes benefit greatly from being stored in diffused light, but this kind of storage makes them inedible, and therefore useless except for seed. Only some farmers could afford the risks of making this early choice regarding the use of the stocks. For those who could, the advantages were very large in terms of later productivity.

Eventually, a whole range of forms of storage techniques and structures using diffused light were created by farmers in full partnership with the research team. The farmers became colleagues and advisors in the research and transfer process. As a result, 3 years after the research began, the principle of using diffused light in rural seed stores had been introduced through CIP's training courses to potato workers in 21 countries.

Another example is the case considered in chapter 4. It concerns the traditional charcoal *jiko* cooking stove that has been widely used in Kenya since the early 1900s. The stoves are made and sold locally. The potential benefits from improving the energy efficiency of the *jiko* are enormous, first in terms of household expenditures for fuel and second to conserve the rapidly dwindling supply of available fuelwood.

IDRC made a small investment in a single developer who subsequently produced successful prototypes of a ceramic-lined *jiko* that could reduce energy consumption by 25%. The design was modified after field trials and local artisans were taught to produce and market the stoves. To this point, the project could be rated a remarkable success, but the method of manufacture by self-employed individuals in Kenya's "informal economy" does not lend itself to supervision or quality control. One result is that ceramic linings are often substandard and require frequent replacement. Less than half of the total number of *jikos* produced appear to be in steady use. The authors suggest that many of them were bought more from curiosity than real need. The artisans do not necessarily understand the energy conservation aspects and cannot explain them convincingly to consumers. The ceramic *jiko* is expensive compared with its ordinary cousin and a low-income family will usually resist or be incapable of making the extra capital outlay even when reduced daily expenditure for charcoal would soon pay back the difference.

The chapter generally makes it plain that the innovation process is not complete, and that further major efforts in product optimization, in manufacturing process and quality control, in marketing, and in financing would still be required for the substitution to become widespread. Radical socioeconomic changes would then be involved, because the traditional practices of local entrepreneurial production and sale make these steps extremely difficult.

The forms of development aid described in these and other chapters would have been unthinkable in the two decades before 1970. The success of the Marshall Plan in reconstructing Europe had then led to the belief that rapid economic growth could follow from the direct transfer of the tools of production. As David Hopper explained in his inaugural address as the first President of IDRC (Hopper 1970), it took time to realize that the postwar success in Europe depended on the availability of European labour already skilled in the use of machinery and other capital-intensive goods. The focus of Third World aid programs was then expanded to include support of academic and vocational education.

Meanwhile, however, agricultural production failed to keep pace with food demand, forcing the realization that much of the technology being transferred and taught was suited only to modern donor cultures and was not adapted to the particular needs of the developing world. Beginning with the agricultural sciences, the emphasis shifted to the transfer of the methodologies for development themselves and their application to the generation of new techniques specifically adapted to the situation. The results in food production were spectacular, again illustrated by this volume, for example, in chapter 11. Later, this practice was extended beyond food production to other developmental needs.

Inevitably, world attention is focused more by bad news than by good news. Desperate problems remain, especially in the drought-stricken areas of the sub-Sahara, but overall the progress has been truly remarkable. In Southeast Asia in particular, numerous countries are now self-sufficient in food and experiencing economic takeoff. Life expectancy in Third World countries has risen steadily and continues to do so. There is much to be proud of and thankful for. As a Canadian, I am glad that we have an IDRC.

In conclusion, it is worth reflecting on the enormous changes in public perception and the world's view since IDRC was founded. In 1970, it was virtually unthinkable that the "towering affluence" of the North could totter and fall to meet the rising prosperity of the South on some common ground yet to be defined. In those days, it was assumed that the world's economy would expand to accommodate everyone on a rising tide of wealth and material consumption. *The Limits to Growth* (Meadows et al. 1972) did much to shatter that dream, especially as it was coupled with the new perspective gained from the Apollo Program, of the Earth as a small and finite ball. Hard on its heels came the first massive oil shock and the steep rise of inflation. We are now living with the knowledge that the long economic upwave after World War II has ended in a mountain of debt accompanied by deflation. We in the industrialized countries are learning to do very much more with very much less in terms of material and energy consumption — and we are even beginning to enjoy doing so. As the world economy stalls and demand drops, there is surplus world capacity for almost all commodities, bringing intractable structural unemployment in its train. For a time, it seemed that the North–South dialogue was almost suspended as nations turned inward to focus on domestic issues, economic losses accumulated, and turmoil and terrorism mounted. This has forced anew a realization of global interdependence and a vital resumption of the dialogue.

No doubt the next 15 years will contain an equivalent set of startling surprises. What seems certain, however, is that the problems of equitable allocation of wealth and of the cultural shocks of new technologies will remain with us. For these reasons, the issues that IDRC serves seem certain to endure.

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CHAPTER TWO

THE ROLE OF RESEARCH IN THIRD WORLD DEVELOPMENT*

A Zimbabwean scientist, Chifumbe Chintu, describes research succinctly as the art of asking and answering questions. This chapter asserts that research undertaken in and by Third World countries is a necessary ingredient for their development. This idea would have been revolutionary until fairly recently: the traditional wisdom being that "science knows no boundaries" and, therefore, that research for developing countries was best done by outside experts. The same thinking applied to development in general: it too could be transferred from the "developed" to the "developing" world.

Development is not something that can be imported, however, nor is it necessarily synonymous with technological advance. On the other hand, it should be consistent with human dignity, which is hard to preserve in conditions of hunger, disease, deprivation, dependence on others, and disrespect for indigenous culture and human rights. Consequently, development must have something to do with people being better off in some way — on their own terms.

Development decisions are basically investment decisions — investment of people and resources. Ideally, those who identify the problems, assess the risks, set the priorities, and make the decisions should be the people of the society where the "development" is to take place. Perhaps the most important thread running through this book is that the people of all nations have the right to determine their own development path. To do this, countries must have the capacity to "ask and answer questions."

The link between research and one aspect of development — productivity growth — has been clearly established. True, some experts

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**This chapter is based on an essay by Frank Campbell, a journalist and diplomat from Guyana with the Caribbean Community in Georgetown.*

believe that trying to establish how much of a country's economic growth is the result of research is "like trying to distribute the credit for the flavour of a cake between the flour, the butter, the eggs and the sugar" (OECD 1980). Nevertheless, an unmistakable correlation has been established between those countries and industries that have a strong research base and those that show productivity growth and other evidence of progress. It has been stated (Ravetz 1971) that "the prosperity and economic independence of a firm or of a nation does not rest so much in its existing factories as in its R&D [research and development] laboratories."

Sustained and self-sustaining progress in a country has generally followed the application of a technology controlled by, and responsive to the needs and endowments of, that country. Imported technology has generally required modification to suit local needs and conditions. Early Canadian development was aided by adapting imported European technology to Canadian resource endowments, such as abundant forests, and to the country's peculiar needs — e.g., communication, transportation, and tools to develop the great expanse of territory. Similarly, Japan — simplistically perceived by many as an industrial copycat — learned early a number of lessons: the validity of its basic indigenous agricultural structures, the need to adapt and not just adopt imported industrial technology, and the need to develop an authentic research capability so as to make optimum use of its development potential (Nakayama 1978).

In this light, the imperative for Third World countries would seem to be not to replicate or "catch up" with industrialized countries per se, but to be able to utilize their own resources effectively to solve national problems and to participate meaningfully in commercial, technological, and cultural exchange. Apart from being apparently unfeasible, the unmitigated replication of the industrial models of the North has at least two dangers. One is the unnecessary repetition of such pitfalls as pollution, waste, depletion, alienation, and unsafe practices. The other is the treatment of a people's culture and values as a hindrance to, rather than an aspect of, the development process. This suggests that development must mean more than the importation of production, consumption, and organizational technologies merely because these have been associated with high production and consumption levels elsewhere.

SCIENCE IN THIRD WORLD HISTORY

Perhaps the relative neglect of indigenous research as a factor in Third World development arises from the view of scientific knowledge as a peculiarly Northern creation. Yet the survival and development of precolonial Asia, Africa, and Latin America were founded to a greater or lesser extent upon indigenous scientific and technological traditions, many of which exercised a profound influence on European civilization.

Indeed, the scientific and technological exchanges between European and other peoples going back several millennia are more and more being revealed. That printing, paper, and gunpowder had been invented in China before they became known in Europe is already well accepted. The influence of Arab science and administration on Europe is exemplified by the number of scientific, commercial, and other terms imported into European languages from Arabic. "Sugar," "alcohol," "cotton," "zero," "algebra," "alkali," and "tariff" are but a few of such terms. Egyptian medicine influenced the Hippocratic collections and the works of Pliny, Galen, Dioscorides, and others in the Greek tradition (Goonatilake 1982a,b). More generally, "Greek science was greatly stimulated by the technological achievements of ancient Egypt, and many of the data it acquired from Egypt were to be used in framing the great generalizations which gave it pre-eminence" (Winter 1952).

The Indus Valley civilization and its offshoot in the Ganges also influenced or were influenced by European science — sometimes directly, sometimes through the Arab world. As early as the 6th century B.C., there was, in the Indus Valley, "an emphasis on and an intense interest in matters that in modern parlance could only be called science" (Goonatilake 1982a,b). Coinage, mathematics (including large numbers and concepts of infinity, pi, and zero), flood irrigation, psychology, architecture (influenced by the Iranians and possibly the Greeks), and surgery and herbal medicine are part of the legacy of early Indian civilization.

African herbal medicines dispensed for centuries by traditional doctors are being studied, codified, and gradually received into the pharmacopoeia of modern practitioners. African herbal and other treatments are believed, for example, to control diabetes and rheumatoid arthritis more effectively than their Western equivalents. African traditional mental health practice employed "free association" before Freud did, and also group therapy, long before it became fashionable in Europe (Nichols 1982).

Bereft of contact with Europe until the "voyages of discovery," the civilizations of the "Indians," as the American continents' inhabitants were mistakenly labeled by Columbus, enjoyed some 10 000 years of autonomous cultural development (Goonatilake 1982a,b). As in the case of Africa, few of the written records they left are yet decipherable, but archaeological and other data reveal significant achievements in agriculture, engineering, and other fields. By the 1st millenium B.C., these civilizations had completed the domestication of maize.

The Incas of Peru and the Central Andes also developed extensive and efficient road systems, mining techniques, monumental temples, and terraced mountainside agriculture (Clarke 1977). The pyramids and temples were made of "fine masonry of basalt with high precision and fitted together without mortar" (Goonatilake 1982a,b). The Inca technology also included large-scale water-management systems and sophisticated land measurement.

This is not to say that Northern traditions are not relevant. A recognition of the value of developed country scientific know-how is quite consistent with the argument for indigenous Third World research. In terms of "method" and as a body of knowledge, the science of the North contains much from which today's developing countries can continue to benefit. An ideal approach for these countries would perhaps combine the best elements of "traditional" and "modern" science.

THE NEED FOR SCIENTIFIC INDEPENDENCE

The role of scientific research in technical progress in the North and the generally unheralded place of science in the history of the South are only part of the case for a "new scientific tradition" in the Third World. Other factors are the existence of special problems confronting the Third World, the amenability of at least some of these problems to resolution through research, and the importance of that research being done by Third World people in their own countries.

From a historical perspective, there are four reasons for the existence of special research problems in Third World nations. First, some problems — or opportunities — are indigenous to those countries going back to the period before large-scale intercontinental contacts. A number of indigenous crops — such as quinoa in Latin America, sweet potatoes in the Philippines, and sorghum in Africa — experienced little improvement for centuries. Second, some problems have been created or exacerbated by the colonial enterprise. A number of health and ecological problems fit into this category. Kjekshus (1977) suggests that East African farmers had overcome the problem of tsetse flies through environmental control. Unfortunately, colonial administrators understood neither the problem nor the solution and introduced game control, forestry, agricultural, and other policies that benefited the tsetse rather than the farmers or their livestock. Third, there are those problems revealed by or resulting from some postcolonial policies, e.g., the thrust toward industrialization. Fourth, there are problems founded upon the global economic system: these include the recession, the energy crisis, and the so-called "debt trap."

The food problem is crucial, pervasive, and demonstrably amenable to scientific resolution. The need for food in much of the developing world — especially parts of Africa — has reached such dramatic proportions as to require no elaboration. It is estimated that four million African children die every year — 10 000 per day — as a consequence of extreme poverty and underdevelopment. The need for food coexists with a tremendous potential, often on the very spots where children and their parents are dying of starvation. Unfortunately, actual land use in much of the Third World still represents only a fraction of potential land use. Even where the land is cultivated, yields are significantly lower than potential. For example, maize yields in much of Africa are 20% of the 5–6 t/ha obtained in Canada. A cassava experiment by the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria, with a minimal fertilizer input, yielded up to 18 times the cassava produced by an average Nigerian farmer on a similar plot of land. This gap between actual and potential production shows that, in many cases, the scientific way does indeed point to tremendous opportunities. If research could identify solutions to the problems of soil fertility, pests, and diseases that suppress agricultural yields — and if these results could be developed into actual programs — the world's food problem would disappear. Another Green Revolution could achieve for many Third World countries what the earlier version has achieved for India and a few others.

Sometimes, the argument is made that many of the problems facing the Third World have already been solved by researchers in the developed countries and that any future research on such problems can benefit from Western facilities. There is more than a grain of validity in that position. Ballantyne (1984) declares that "hybrid chickens may lay as many eggs per year in a wire cage in Nigeria as in Holland." The polio vaccines worked wonders in both North and South. European hydraulic techniques have been employed to great advantage in the South. There is little reason for Africa or Latin America to reinvent the clock or the radio, let alone the wheel. However, there are limits to the transferability of technology and, less so, of scientific learning, even between one developed country and another. The reasons for this can be grouped in three categories: ecological factors, resource endowment, and sociocultural factors.

In making his point about hybrid chickens doing equally well in Dutch or Nigerian wire cages, Ballantyne (1984:196) goes on to point out that "the same is not true of the field production from seed potatoes exported to Nigeria from Holland." Agriculturists and other scientists have noted that ecological factors can vary significantly not only from country to country but even interprovincially. Soils, winds, and microclimates can differ sufficiently between two areas separated by only 1 km to require differing agricultural strategies. As agricultural research has matured, it has been necessary to have research projects in a number of regions for each crop or animal being studied. Even though crop scientists may attack the same problems — productivity or resistance to disease and pests — and be concerned with the same crop, site-specific research is crucial.

Of course, the ecological factor applies to many studies apart from agriculture. For example, a temperate forest might contain 25 species and ecosystems whereas a tropical forest might contain hundreds, even thousands. The nature, cause, and treatment of health problems are all quite different between the North and South. Engineering technologies designed for temperate climates often require radical adaptation to function in tropical zones.

Related to the ecological factor is that of resource endowment. The indiscriminate importation of labour-saving, capital-intensive technology into a capital-poor, labour-intensive economy may impede rather than facilitate development. The technology in Indian steel plants quite logically differs from that in United States steel plants because of differing factor endowments. This does not mean that a country should strive for total technological self-sufficiency. Countries with small oil deposits do not need to develop a new technology to suit their endowments. Much more important is the capability to identify the most appropriate technology and the best supply source. It is often unnecessary to reinvent the wheel when it would be enough to find the right type and size for local needs.

Sociocultural factors can also inhibit the transfer of science and technology. This statement gives the impression that sociocultural factors are somehow getting in the way of development, whereas of course it has been argued earlier that these factors are a part of development. If that is accepted, then it becomes more a question of transferring technology as ideas, rather than as hardware. Several of the case studies later in this volume exemplify this point. For example, in the context of a rural village in Sierra Leone (chapter 7), nothing was transferred but the notion that clean water and disposal of excreta help to improve health. The people themselves then "researched" a way of doing these things that was feasible and that fitted their way of life, again adapting some simple technologies to local resources.

Even if technological transfer is possible, it can in some cases work against the need for autonomy and self-sustaining growth, two elements vital to development. Although it is sometimes assumed that self-sustenance would result from a simple cycle of investment leading to capital formation and, in turn, to further investment, the process would work in the best interests of development only if the "best" set of opportunities is identified, the right technological choices are made, and problems are solved. Genuine self-sustaining development is inconsistent with assuming that the answer to every new problem can be found externally. Third World countries need both to have their research questions answered and the capacity to do their own research.

THE STATE OF THIRD WORLD RESEARCH

Postcolonial societies vary significantly in their research capacities. At one extreme are the newly industrialized countries (NICs), at the other, the research-deficient countries of Africa.

Korea's Ministry of Science and Technology, established in 1967, was perhaps the first in a developing country. Subsequently R&D investment in that country grew by 30% yearly, on average, to USD 610 million by 1981. This was 0.97% of gross national product (GNP). The Fifth Five-Year Science and Technology Development Plan (1982–1986) aimed to take R&D investment over the 2% mark by 1986 (Government of Korea 1983). This is extremely high by developing country standards and comparable to the ratios in many richer industrialized countries. Japan spent 1.9% of its gross domestic product (GDP) on domestic R&D in 1977 and projected an expenditure of 2.5% in 1985. The corresponding Canadian figure for the mid-1980s is around 1.3% (of GDP).

Moravcsik (1981) celebrates the fact that the link between science and technology on the one hand and economic development on the other is now "not restricted to the so-called developed countries." He adds that

> this gives hope to the other countries still behind that, given the conducive indigenous environment, they may be able to make significant economic strides also within the span of, say, five decades, a time period which is short compared with the length of the similar historical evolution of the now developed countries.

Hope there may be, but the position in most developing countries can be quite discouraging. Countries such as Brazil, India, and Korea are the exception. Overall, Third World R&D expenditures as a proportion of global R&D expenditures have been estimated to be as low as 2% although some estimates are somewhat higher. Scientists engaged in R&D and living in the Third World number half a million compared with four million in developed countries. In the Commonwealth Caribbean, Jamaica spends about 0.42% and Trinidad and Tobago 0.26% of GNP on R&D (Girvan 1983). In some countries, the ratios are even lower. The inequity becomes more palpable when a 1.3% R&D ratio in a country such as Canada, with a per-capita income of USD 12 300, is compared with a 0.2% expenditure in a developing country that has a per-capita national income of USD 200. This is equivalent to comparing an R&D expenditure of USD 160/person per year with one of USD 0.40/person per year.

Apart from basic lack of resources, there are other problems that Third World scientists face. One is the level of their training. The second is the relevance of that training — usually obtained in a developed country environment — and its orientation to the local situation. A third is the paucity of opportunity for intellectual interchange with their peers. Many a Third World researcher is an intellectual recluse: the nearest person researching, or specializing, in the same field can be hundreds or thousands of miles away (Nichols 1982). Another problem is low pay. One Canadian social scientist recalls teaching two classes per week at an Asian university and having enough time and other resources to do research. His local colleagues, meanwhile, taught two or three classes per day, then "moonlighted" at high schools "to make a living." They had neither time, energy, nor funds for research.

GROUNDS FOR OPTIMISM: WHAT CAN BE DONE

Despite these difficulties, there is hope. That African governments have set targets for R&D investment levels indicates at least an awareness of the value of scientific solutions to the continent's pressing problems. Many have been prevented by recession from achieving their goals. Nonetheless, allocations for R&D have been increasing in many cases and included in national budgets for the first time in others. More and more national research institutes and even ministries of science and technology have been added to national administrative structures. Although progress is slow, some scientists report greater acceptance of their work and their worth.

In terms of size of scientific work force, India is placed third after the USA and the USSR. With its enormous research infrastructure, India is able to pay increasing attention to industrial research without neglecting the continuing need for agricultural research. An example of the thrust in industrial research relates to the country's 2000-year coal supply. Indian coal, because of its excessive ash content, produces high levels of erosion, emission, and residue and is, therefore, practically unusable in steel manufacture. Although importing coal for its steel industry, India is seeking a long-term solution to this dilemma through research.

India's most dramatic achievement in the area of research has, perhaps, been in agriculture. The success of the Green Revolution in India has transformed that country, a so-called "basket case" in the 1950s, to one with a grain surplus so large as to create a distribution problem. It is important to note that the contribution of the high-yielding wheat and rice varieties of the Green Revolution to global food production, particularly in Asia, was made possible through genuinely international efforts. These varieties have resulted in an annual worldwide increase of 50×10^6 t of grain — enough food for some 500 million people. Much of the basic research was conducted in international centres, especially the Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT, International Centre for Maize and Wheat Improvement) in Mexico and the International Rice Research Institute (IRRI) in the Philippines. For this work to bear fruit, however, the seeds had to fall on fertile ground in the sense of national institutions capable of doing adaptive research, of demonstrating and extending the technology to farmers, of ensuring supplies of the requisite inputs (such as water, fertilizer, and pesticides), and of marketing and distributing the produce. Such ground was found in India and other countries in Asia.

Another indication of what research in the Third World can achieve is the success of the Special Programme for Research and Training in Tropical Diseases — Tropical Disease Research or TDR for short. TDR is administered by the World Health Organization (WHO) in association with the United Nations Development Programme (UNDP) and the World Bank. Thanks to this program, 66% of the research on tropical diseases now takes place where it belongs — in tropical countries: more specifically in those developing countries where the diseases are endemic. In 1977, only about 20% of this research was in the developing world. More significantly, most of the research today is done by developing country scientists. Between 1975 and 1979, the TDR centre established in Ndola, Zambia, for biomedical research and training in Africa was staffed entirely by WHO experts. By 1984, there were 26 national staff members and only 5 from WHO. A major objective of TDR is to strengthen research capability in the 125 participating endemic countries through research experience and local and external training. There are two sides to TDR — one is the research and other activities done in these 125 countries; the other is the international network that coordinates all research, including that of developed country researchers, whose role remains crucial.

The success of the program has been twofold. TDR units have strengthened their countries' ability to deal with the seven types of TDR target diseases — malaria, schistosomiasis, filariasis, African trypanosomiases, Chagas' disease, the leishmaniases, and leprosy. In addition, this combination of localized Third World research activities and the international network enables the program to report that "the present, third, stage in TDR's development is marked by results: usable products and technologies are emerging from work supported by the program" (WHO 1985).

For example, in malaria, research within and without the TDR program has led to optimism that the development of an antimalarial vaccine might be imminent (Godson 1985; WHO 1985). Several antimalarial compounds, including one originally extracted from a traditional herbal remedy in cooperation with Chinese scientists, are at an advanced stage of development (WHO 1985). One, mefloquine, already registered for human use, has been tried successfully in Africa, Asia, and Latin America.

WHO reports that significant advances have also been achieved on a leprosy vaccine and on new multidrug treatment schedules to reduce the duration of treatment and diminish the risk of drug-resistant strains emerging. New techniques in vector control are also being developed under TDR.

THE LIMITATIONS OF THIRD WORLD R&D

The purpose of the previous emphasis on "winners" is to establish that Third World research has great prospects, not to conceal that there are "losers." Also, quite apart from the ethical debate on certain kinds of research — genetics, weaponry, etc. — research as an engine of national and international development has clear limitations.

Research is a necessary condition for the development of Third World countries in that the latter cannot take place without the former; however, research is not a sufficient condition for that development. Other factors are more or less necessary if development is to take place. Among them are a carefully conceived overall science and technology (S&T) strategy; a conducive research environment; favourable domestic social, political, and economic factors; a conducive international environment; and time.

Research, being a process, is not easily imported. On the other hand, an S&T policy encompasses knowledge, systems, and artifacts whether locally produced or externally acquired. S&T is the whole — research is the part and is most effective if it fits into an overall S&T strategy. A country needs to decide on, first, the development path; second, the concomitant S&T strategy; and, on those bases, third, what element of the S&T package requires local research. Autonomy does not require research on and development of a new, local technology when an existing foreign technology would suffice. All that is required is that when technology is imported, it should be carefully selected, relevant, adapted to local conditions, and, where appropriate, it should be "disaggregated" so that certain elements might be provided locally with or without the help of local R&D (Girvan 1983).

Such a comprehensive S&T policy would be a good sign of a conducive research environment, one in which researchers are able to produce and communicate research results, and in which the populace, government, and private sector have the will, capability, and appreciation to make optimum use of those results.

Intellectual solitude among Third World scientists hinders the creation of such an environment. The self-confidence, stimulation, and effectiveness of a scientist depend on contact and exchange with his or her peers. The need for networks is, therefore, often paramount. Researchers can only be effective if they have access to the writings of their colleagues and outlets for their own work. Unfortunately, the role of libraries, documentation centres, and so on is even less appreciated in many developing countries than that of researchers. For this reason, Third World governments have probably spent, on the aggregate, many millions of dollars to pay for feasibility and other studies when the information produced could have been obtained for much less from local archives or international data banks. The purpose of research is to produce knowledge, but much more knowledge required for development is already available than is likely to be produced any time soon.

Another necessary part of a conducive environment is all that institutional apparatus that looks after the "D" in R&D. The best research results are only of academic interest until transformed into policies, products, and systems — or "D." Development in this narrower but important sense is as lacking as is research in the Third World.

Favourable domestic social, political, and economic conditions and, second, a conducive international environment clearly cover a wide range of factors. No attempt can be made to cover them here. However, it can be agreed that persistent social or political instability, inadequate capital formation, or poor public administration are not easily overcome by greater expenditures for R&D — nor are seriously disadvantageous terms of trade, global monetary instability, or harmful trade barriers. This is not to suggest that these problems are not themselves amenable to scrutiny by researchers, or that research aimed at confronting a specific problem cannot be successful while these major barriers to overall national development remain.

One element that is often insufficiently considered in planning, implementing, or evaluating development is time. As Moravcsik (1981) has noted, if a developing country, propelled by the self-sustaining research–development–economy–research loop, were to "develop" within 50 years, that country would be doing better than the developed countries of today. According to Professor Clive Thomas (1985), 8–15 years is considered a reasonable time lag from the generation of a research idea to the implementation of the corresponding research results. Where research or other capacities are being developed from scratch, even 8–15 years can be too short a gestation period.

> Development takes time, and this even when certain basic knowledge is available. The Athabaska tar sands, for example, were known to the Hudson's Bay Company in 1718. The technique employed to separate oil from sand was discovered in the early 1930s. But the combination of circumstances required to exploit commercially this resource did not occur until 1964 .... [Head 1983:15]

This is neither intended as special pleading for Third World countries nor as an excuse for inaction on the part of their governments. Indeed, given the possibility of leap-frogging many of the phases through which the now-developed countries have passed, there is no reason why the centuries those countries spent achieving technical progress should be repeated by today's developing countries. On the other hand, development does take time. This has to be borne in mind in any assessment of the development process in nation states barely half as old as the 50 years suggested by Moravcsik (1981), or those whose national research agencies are not half as old as the 15 years needed, according to Thomas (1985), for the maturation of a single research endeavour.

CONCLUSION

An attempt has been made above to show that research, particularly indigenous research, is a necessary condition for development in the Third World; that some useful research has been and is being done; and that research is not a sufficient condition for development.

IDRC has had to be conscious of these three propositions about research: the necessity, the success, and the limitation. The belief of the Canadian Parliament that indigenous research was a necessary condition for development led to the Centre's establishment in 1970. IDRC's role has been not to conduct research but to support the efforts of Third World researchers financially and otherwise.

The next chapter outlines some of the IDRC story from 1970 to 1985 — a turbulent period in Third World history. In essence, if this chapter has made the case for indigenous research, the next relates what one particular agency has done about it.

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CHAPTER THREE

IDRC AND THIRD WORLD RESEARCHERS: THE PRODUCTS OF PARTNERSHIP*

Despite its name, the International Development Research Centre has done very little research on international development since its creation in 1970. Its activities have been based on the simple notion that people must create their own development and this chapter examines how IDRC has helped Third World countries to do that.

WHAT IS IDRC?

Jamaica's Rex Nettleford, a governor of IDRC until recently and for most of its 15 years, described the Centre as "a revolutionary, if strange, institution" (Nettleford 1979:69). Before reviewing some of the products of IDRC's partnership with the international research community, it is useful to examine this "strange" and "revolutionary" institution.

The Pearson Report of 1969 was the world's way of acknowledging that neither political independence, foreign aid, nor industrialization provided adequate answers to the problems of underdevelopment, and that new approaches, including indigenous research, had to be taken. The report noted that

> a large effort is needed to absorb, adapt, and develop scientific and technical knowledge in developing countries. Research institutes and development corporations should be established in potentially rewarding fields [Pearson et al. 1969:21].

**This chapter is based on a report prepared by Frank Campbell, a journalist and diplomat from Guyana with the Caribbean Community in Georgetown.*

IDRC was Canada's pioneering way of translating this proposal into action. In moving the second reading of the IDRC Bill in the House of Commons on 12 January 1970, then Secretary of State for External Affairs Mitchell Sharp (1970:2249) declared

> The measure is one of the most promising and exciting proposals to come before this House for a long time.... This can be a new and dynamic element in Canada's contribution to the global struggle to improve the quality of life in the less privileged areas of the world.

The Bill was greeted with enthusiasm and fervour by representatives of all three political parties. No less remarkable was the grasp among speakers in the debate of the need for a departure from, or at least a supplement to, conventional approaches if development aid was to be effective. Gordon Fairweather (1970:2253), at that time the Progressive Conservative Party's foreign affairs critic, told the House

> We have learned that we cannot superimpose on others, as we used to think we could, our cultures, our ethics and institutions as the price for aid.... We have learned that ways of doing things which may be perfectly acceptable to Canada are not necessarily wise or valid in other countries.

Enthusiasm for the new Centre was not confined to the House of Commons. The Senate helped to strengthen the Bill, sending it back to the Commons with amendments. The Senators provided a formula for describing the Centre's taxation status without the unnecessary implications of the term "charity." The preparatory work for the Centre's establishment was presided over by Maurice Strong, then President of the Canadian International Development Agency (CIDA), and attracted the collaboration of Canadian academics and of various government departments and agencies. The establishment of IDRC also followed extensive international consultations. Mr Sharp was thus able to "assure the House that Canada's initiative in creating this body is welcomed by the entire international development community" (Sharp 1970:2251). One Member of Parliament revealed that his endorsement of the Bill was fortified by the known support of Canadians for a more assertive and effective role in international development.

The institution emerging from these debates and consultations was unique in terms of its objectives, its powers, its structure, and its operations. According to the IDRC Act (Government of Canada 1970), a corporation was established "... to be called the International Development Research Centre consisting of a Board of Governors that is composed of a Chairman, President and not more than nineteen other governors ...." Thus, IDRC is a Board of Governors, of which 11 members must be Canadian, 10 have traditionally been non-Canadian and six of them scientists of international repute from the Third World.

The main objectives, according to the Act, are to

> ... initiate, encourage, support and conduct research into the problems of the developing regions of the world and into the means for applying and adapting scientific, technical and other knowledge to the economic and social advancement of those regions ....

Parliament, conscious as it demonstrably was of the nature of research for development, left the Centre free to support both Canadian and other, including Third World, scientists. IDRC was required "to assist the developing regions to build up the research capabilities, the innovative skills and the institutions required to solve their problems...." Parliament also recognized the need to establish at least two kinds of linkages. It charged the Centre "to encourage generally the coordination of international development research, and to foster cooperation in research on development problems between the developed and developing regions for their mutual benefit."

In their debate during the second and third readings of the Bill and during the committee stage, as well as in the Act they finally hammered out, parliamentarians on both sides and in both chambers expressed their wish that the Centre be as free as possible of governmental influence. Section 18 of the Act specifies that "the Centre is not an agent of Her Majesty...." The officers and employees of the Centre — not to mention the members of the Board — are not part of the Canadian public service except, where applicable, for purposes of the pension legislation. However, there are two ways in which the IDRC accounts for its stewardship to Canadian taxpayers. One is through an annual report by the Chairman transmitted to Parliament through the Secretary of State for External Affairs or any other Minister designated by the Governor in Council. The other is through an annual audit of the Centre's "accounts and financial transactions" by the Auditor General.

The flexibility permitted by the legislation and the strength of succeeding Boards have allowed innovative policies and experiments to be implemented. Some of these are described below and in the chapters that follow. The emphasis on working with Third World scientists may have exceeded even the expectations of the authors of the IDRC Act although, as will be shown, there has been an increasing role for Canadian researchers in recent years. With few exceptions, IDRC-funded research has been conducted in and for the less-developed countries by researchers of those countries.

Undoubtedly, this emphasis on developing country researchers is one of the major tenets of the Centre's first 15 years of operation. Another is the philosophy of "responsiveness." In the history of international development, it has been rare for a donor institution in a developed country to be as sensitive to the priorities established by developing country governments, agencies, and individuals; and in the words of the Auditor General of Canada (1982:2), "IDRC acts as a catalyst, an adviser, a supporter. It monitors but does not manage the research projects it supports."

Of course, this policy of responsiveness is not absolute. Some of the most productive programs have resulted from the initiative of Centre staff. Such initiatives are perhaps allowable even in the context of a responsive philosophy. After all, a large proportion of the Centre's governors and staff either have roots in developing countries or have acquired over time a familiarity with the problems of those countries. Many are authorities in research fields funded by the Centre. IDRC's employees — functioning in Ottawa and at the Centre's six regional offices in Africa, Asia, and Latin America — come from more than 50 countries, speak more than 60 languages, and are the holders of an aggregate of hundreds of university degrees, diplomas, and certificates. The combination of staff effort and responsiveness is no doubt reflected in the comment made by the Auditor General (1982:4) after a comprehensive review in 1981 of IDRC's effectiveness.

> IDRC operates with highly qualified, experienced and dedicated professionals renowned in their fields. Most project recipients we interviewed considered the IDRC approach superior to that of other international aid agencies.

A desire for concrete solutions to real problems is another aspect of the Centre's operation. This desire is expressed in the emphasis on applied research — or research intended to produce specific solutions to specific problems. The relative neglect of more basic research has not been universally popular among Third World scientists. Some argue that support for basic research in Third World countries is necessary if applied research in these countries is not to be founded on inapplicable theoretical assumptions generated in a different environment. Although not unsympathetic to such views, the Centre has remained convinced that its limited resources could best be expended on research with the prospect of early human benefit.

Scarce resources have limited the subject areas to which IDRC provides funding. The main research areas funded by the Centre are expressed in the names of its three major research divisions: Agriculture, Food and Nutrition Sciences, Health Sciences, and Social Sciences. Research in these areas is also funded through the Cooperative Programs Division, which is designed to bring Canadian and Third World scientists together in collaborative research efforts. This division also supports research in other areas for which Canada has particular competence. Other divisions, such as Information Sciences, Communications, and Fellowships and Awards, do not support research per se, but offer elements indispensable to the research process, such as developing information systems, applying computers, disseminating research results, and providing appropriate training.

HOW IDRC WORKS

People and Ideas

First comes the idea: in the mind of a researcher in a developing country or in Canada. The idea is related to seeking knowledge — or ways in which it could be better organized, made available, or disseminated. The knowledge will contribute to exploiting a development opportunity or to solving a problem. The "researcher" need not necessarily have a formal degree, but must be attached to an institution — a university, ministry, or nongovernmental organization (NGO) — that is able to support the conduct of a research activity. Most institutions are national, but some have regional or international coverage.

Contact

The contact may be personal — when the researcher meets an IDRC staff member who is "on the road," at one of the six regional offices, or at a project identification meeting convened by the Centre — or the researcher may mail the idea or a formal proposal to the Centre. The proposal usually pertains to research, but may also be a request for training assistance or for technical advice in a particular area, such as information systems.

Consideration

Depending on the topic, the proposal will be examined by IDRC professional staff in the area concerned: agriculture, health, social sciences, information, communications, or earth sciences among others. Program staff become acquainted with the institution and consider the proposal in the light of several questions, such as

- Is it a national priority in the researcher's country and a program priority in IDRC?
- Does it make maximum use of local resources?
- Are there prospects of early human benefit?
- Are there similar activities to which this one might be linked?
- Is the cost reasonable and are funds available?

A more detailed proposal may be requested and almost invariably a program officer will visit the institution to consult the proposer. Where a project includes collaborative research between Canadian and Third World research teams, the Centre will fund a meeting of the teams to develop the idea. If specialist knowledge that the Centre does not have is needed, the proposal is sent for external peer review.

Approval

Once informal agreement is reached, a program officer is responsible for preparing a project summary. This consists of the proposal, suitably translated and edited but faithful to the original, setting out the background, objectives, methodology, and a budget. An appraisal by program staff explains to the President or the Board of IDRC why the proposal should be supported. The Centre provides grants of, on average, CAD 100 000–200 000 over a 2- or 3-year period for each project phase. The range has been from about CAD 5000 to 1.1 million, but these extremes are rare. Expenses may cover remuneration for research assistants, field workers, and technicians; operating research expenses (paper, gasoline, and chemicals); travel costs; some equipment (vehicles, laboratory equipment, and small computers); consultants; publications; and training and workshop expenses. The budget also spells out the contribution of the host institution to the project activities. The salary of the principal investigator is normally part of this contribution.

Implementation

Once the project is approved and both parties — the Centre and host institution — have signed the Memorandum of Grant Conditions, the first payment is made. Then, the implementation and management of the project are the entire responsibility of the recipient institution. Progress and final reports must be submitted and payments are made according to an agreed schedule. Program staff will visit the project for monitoring according to need, usually at least once each year. If it is felt at the end of the project that there is further work to be done, and in many areas of science 2–3 years is too short a time to expect significant results, a second-phase proposal is submitted to the Centre, unless the institution is able to incorporate the activity into its regular budget.

A LOOK AT OUTPUTS

The creators of IDRC were apparently conscious of the fact that research does not produce results overnight. During the debate on the Act, the Conservative Foreign Affairs Critic, Gordon Fairweather (1970:2253), told the House

> I would say that Canadians can't expect any quick results .... I suspect it will not be in the next five years or even in the next decade that the results of the research projects shared with the world through this Centre will make themselves felt in the poorer countries.

Researchers have long recognized the complexity of measuring the impact of science and technology on development. This complexity is compounded for an organization like IDRC, which has funded more than 2000 projects in 900 institutions in more than 100 countries, whose cultural, political, ideological, and other differences are immeasurable. However, the Centre is now 15 years old. In that period, total Canadian aid allocations have been CAD 16 billion (10^9), of which IDRC's grant has been 3%, or CAD 500 million. The Centre's annual budget has grown to CAD 86 million (1985/86) — about 4% of official development assistance (ODA) and equivalent to 25% of the funds available annually to Canadian scientists through one granting body, the National Science and Engineering Research Council (NSERC). Dedicated to the research needs of more than 100 developing countries, IDRC's budget can also be compared with the total expenditure on research and development (R&D) in Canada alone — CAD $6 billion/year. Thus, in purely financial terms, IDRC is a minor player. Nevertheless, it is timely to take stock of the Centre's contribution, focusing initially on the more immediate and obvious "outputs," such as people trained and research results obtained. Later chapters deal with the more difficult question of development effects or "impact" arising from research.

This chapter takes account of three distinct but related research needs facing developing countries and identified in chapter 2 and in the IDRC Act.

- One is to establish or enhance these countries' research capacities.
- Another is to find answers to their specific and very pressing research questions — in other words, to produce research results.

- A third is to reduce the intellectual isolation referred to earlier, and to establish links among researchers and between them and policymakers, donors, extension workers, investors, and the community, both domestic and international.

Separate accounting under these three headings is not feasible because most Centre activities make contributions to all of them. However, they correspond to key elements in the Centre's mandate and, as such, form a useful, if simplified, basis for discussion.

BUILDING RESEARCH CAPACITY

There are, broadly speaking, two reasons why helping to build research capacity in Third World countries has been so important to IDRC. One is that the task is an integral part of the Centre's mandate. The other is that the Centre cannot support Third World research if there are no Third World researchers, facilities, and institutions capable of absorbing such support.

Professor A.F.W. Plumptre (1975:164), one of the senior Canadian academics who helped to establish IDRC, has noted that "... a problem emerges, in particular countries especially, of too many dollars chasing too few scholars." Many developing countries have fewer than 10 scientists per 10 000 population, compared with an average of more than 220 per 10 000 for the 20 leading industrialized countries. Without joining the debate as to whether the numbers of scientists in industrialized countries are above or below the optimum, the numbers in the poorer developing countries are certainly below it, and in some cases below the minimum critical mass needed for a meaningful contribution to development.

BASIC SKILLS AND QUALIFICATIONS

Research activities in developing countries are often handicapped by the need for basic science training and middle-level technical skills, not for sophisticated scientific expertise. IDRC has contributed to this need over the past 15 years in two important ways: by providing training funds as part of research projects — so that the development of skills is geared to a specific research task being undertaken in the trainee's own country — and by providing specialized training not tied to specific projects but in subject areas corresponding to the Centre's programs. Some 7000 persons have received formal training — postgraduate, undergraduate, and special courses (Fig. 1). All but 200 of these trainees have been nationals of developing countries. About 25% of the more than 6000 persons who were trained as part of projects were working toward a degree, mostly at the bachelor's or master's level. Similarly, 900 of the 1000 training awards given outside projects were below the doctoral level. IDRC has not tried to claim that doctorates were unnecessary, but has husbanded its resources to make a more significant contribution to the relative lack of middle-level skills and qualifications. For example, the estimated 4700 in-project trainees not working toward a degree included many undergraduates and technicians attend-

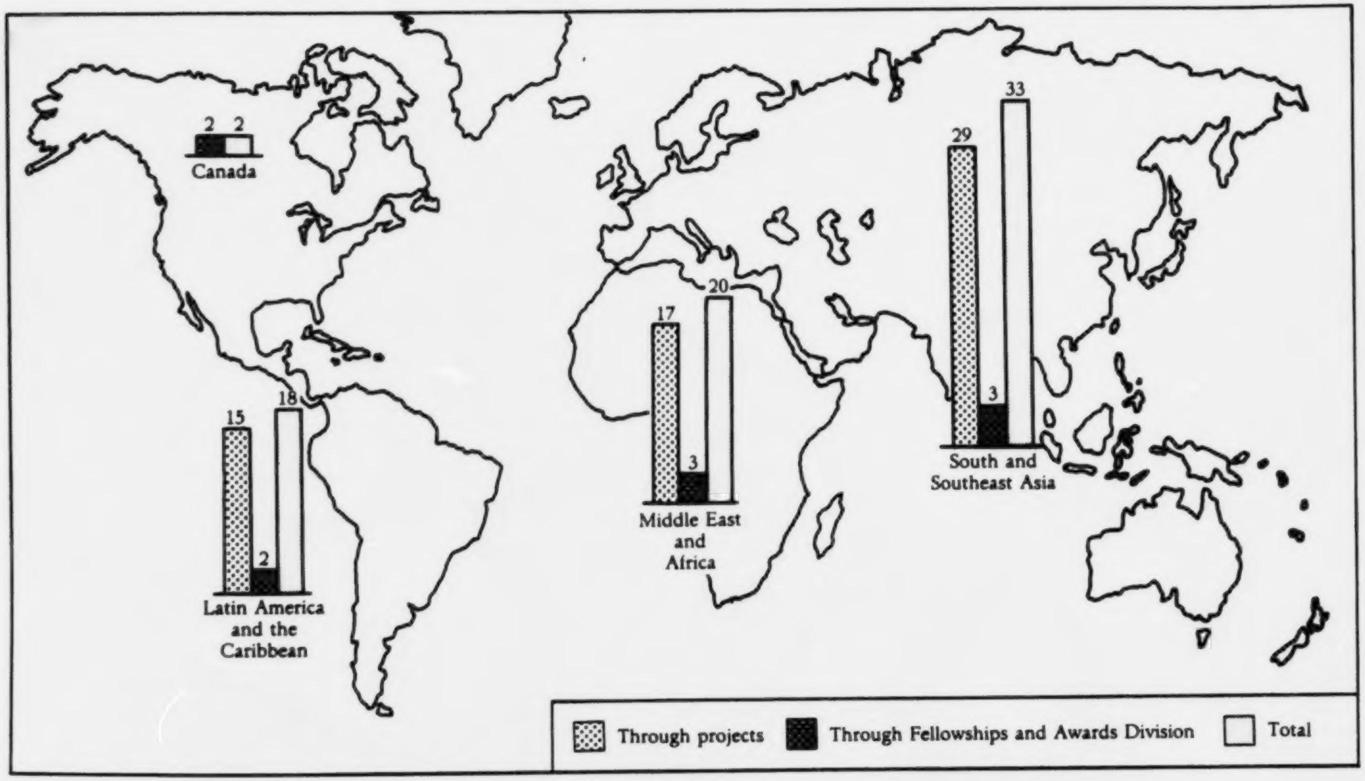

Fig. 1. Numbers of people formally trained through IDRC support, by region, 1970–1985 (numerical values on the bars are in hundreds).

ing special courses and workshops designed for the particular needs of the projects.

A follow-up survey of 750 IDRC trainees that was carried out in 1980 indicated that 97% of those who had been trained abroad returned home. This "brain conservation" rate is attributed to the practice of linking the training to a research project in the trainee's own country, hence providing the incentive to return to a job to which the training is relevant.

The potential importance to a research project of the provision of basic skills or qualification can be illustrated by the *Groundnut Improvement Project* in Mozambique. In reviewing the first phase, the project leader, Dunstan Malithano, emphasized that training had been an integral part of the project right from its inception. Fourteen students were sent to India on a study tour and seven agricultural officials, including the project advisor, were given training in neighbouring African countries. Much of this training was in the form of upgrading for senior researchers. What was perhaps most significant, however, was the training of ordinary workers as agricultural field assistants to help meet the considerable need for such personnel. As Dr Malithano says, "A case in point is that of Mr Salamao B. Chilengue who, before he started working on the project in 1976, was a cleaner in the Faculty [and] is now one of the best field assistants."

As with most projects, the training was not an end in itself but a means of making this agricultural project one of the best organized in Mozambique. The activity has been sufficiently advanced and resilient to meet the urgent call for groundnut seed during recent famine conditions: this without loss of varieties essential to the research program.

UPGRADING AND "FEET-WETTING"

Upgrading the skills of already qualified scientists is a different but equally important approach. Such upgrading can, in the words of the late Jorge Sabato, a renowned Latin American researcher, equip them "so that we from the Third World can now go to any meeting with our colleagues from the developed world, and not be second-best anymore" (Sabato 1979:39). It can provide the capability required for a particular project or series of projects or it can take the form of giving qualified but inexperienced researchers an opportunity to "get their feet wet" by providing them with the resources to do research. About 10 000 researchers from developing countries have gained research experience on projects supported by IDRC (Fig. 2). About two-thirds of these were senior researchers, usually postgraduates, and the other third were more junior. Missing from the values in the figure are many hundreds of information specialists, science writers, research managers, and administrators who have been involved in research-complementing activities. About 700 Canadian researchers have also been supported.

"On-the-job learning" is arguably the best form of training, especially when the job is research that is being conducted in a Third World country and related to its development. For example, a project called

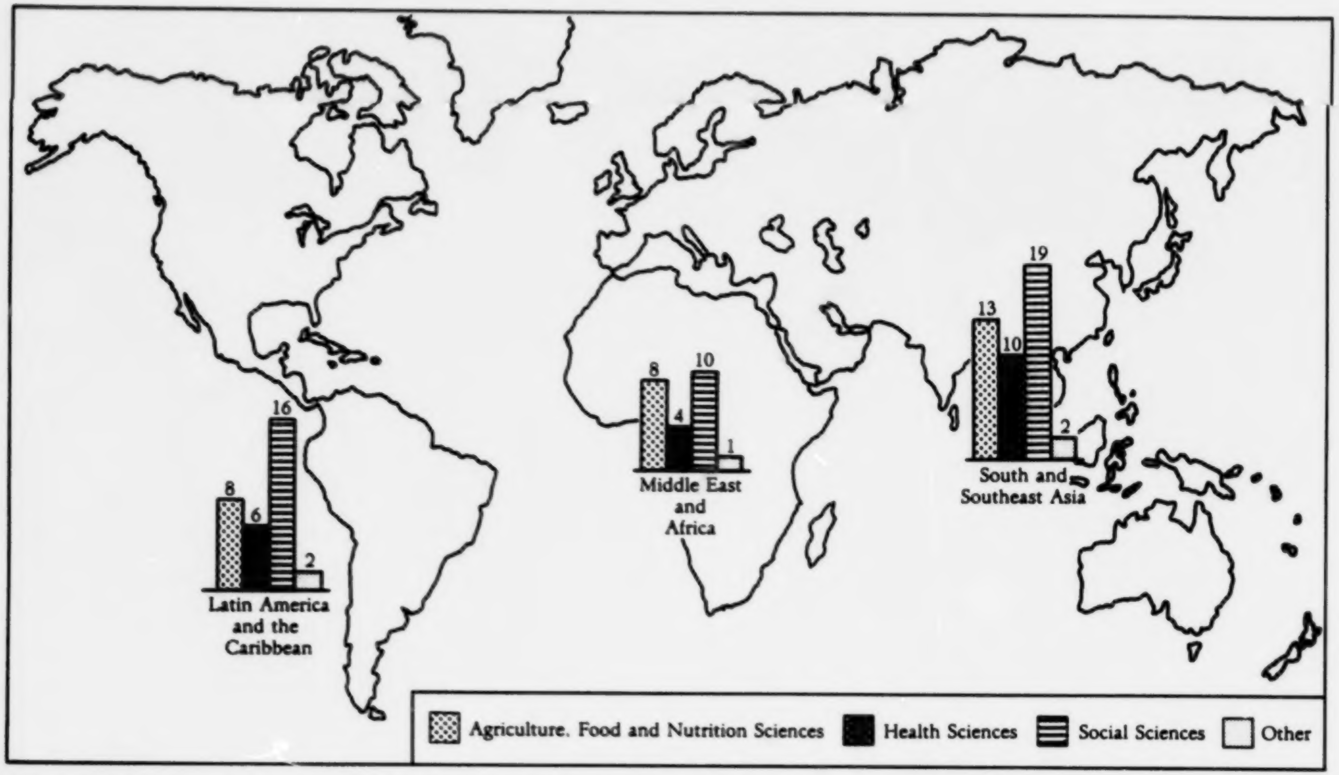

Fig. 2. Estimated numbers of researchers from developing countries who have been involved in IDRC-supported projects, 1980–1985 (numerical values on the bars are in hundreds).

Methodological Research on Population Health and Development provides West African researchers with the opportunity to grasp the appropriate methodologies and conceptual framework to be able to establish trends, levels, and determinants of mortality, particularly child mortality, and of debilitating diseases in developing countries. Thus, the capacity of these African researchers to investigate the levels of mortality and ill health in their regions and the reasons for such high levels is strengthened.

Although most on-the-job learning opportunities have been provided through the 2300 separate project phases that IDRC has supported, there have been variations on the theme. The "regular" project has cost CAD 100 000–200 000, channeled through an institution to a team of researchers working on a set of defined research tasks. A further 20 "small grants projects" have given support directly to 570 young Third World scientists to work as individuals on a research topic. Although half of them already held doctorates, many used the small grant to complete their graduate degrees. A recent assessment of these 20 initiatives shows that most grant recipients have stayed in the same research field and have published the results of their work. Some have since participated in "regular" IDRC projects.

One of the small-grants programs to help young researchers "get their feet wet" was the Programa Latinoamericano de Investigaciones en Reproducción Humana (PLAMIRH, Latin American Research Program in Human Reproduction). The need for research into human reproduction in developing countries was recognized in the early 1970s by a number of agencies, including the World Health Organization (WHO). PLAMIRH, funded by IDRC and by the Ford Foundation, was an attempt to fill this need. From 1974 to 1979, 136 Latin American researchers, joined by 266 junior associates, produced more than 350 research publications: 88 of these appeared in international journals.

APPROPRIATE SKILLS AND ORIENTATIONS

Sometimes, IDRC-related projects provide training opportunities for researchers because the projects are so novel that new skills or orientations are necessary. As examples, the emphasis on links between researchers and farmers in a project in Caqueza, Colombia, required that some agricultural staff be trained in "nonbiological fields, particularly in communications and education" (Zandstra et al. 1979:251). Philippine agriculturist Florencio A. Saladaga received a scholarship from IDRC to study overseas for his doctorate in plant breeding. His people in Talogon on Cebu Island in the central Philippines laughed when they heard he had gone away to learn about the sweet potato. The idea of scientific research on sweet potato, the "poor man's crop," was unthinkable. However, the competence that Dr Saladaga acquired in this new field is helping transform this crop into one of major economic significance in the Philippines. Dr Saladaga's work has been recognized and respected by the farming and academic communities and the Philippines government.

These cases illustrate the belief of the Centre in the need to look for gaps. Generally speaking, most agricultural research in developing countries had been devoted to the commercial plantation crops — tea, coffee, rubber, cotton, and sugar — that held such lucrative appeal to the colonial powers. Even in postindependence days, there was a tendency to give more attention to the more glamorous, higher-technology potential: hence the gap. What about those people living in regions with limited or zero irrigation possibilities, such as the Sahel? What about research on the crops that they actually eat — cassava, sorghum, yams, and sweet potatoes? IDRC felt that a focus on these semi-arid areas and on these kinds of crops would be "appropriate," in the sense that it would help to direct indigenous and international skills to neglected peoples and commodities.

HUMAN AND INSTITUTIONAL SUPPORT TO RESEARCH

Doing useful research requires more than scientists and scientific equipment. Research requires a supporting "infrastructure," and captured within that fashionable term are the abilities of people and institutions to perform a number of functions from the mundane to the more exotic, but all essential: customs clearance, budgeting, planning, typing, searching literature, doing lab tests, making brochures, and organizing visits and workshops. One drawback of the project approach to supporting research is that some of these necessary elements can be overlooked or not qualify for funding. One solution is to do things in stages: concentrating at first on building up human and institutional abilities through on-the-job learning in research projects, then working more on conducting better quality research in subsequent phases.

In June 1985, IDRC approved a project to develop a new process to produce a yellow-fever vaccine and to test the vaccine's conformity with WHO's standards for potency, immunogenicity, stability, and low neurotoxicity. The Fundação Oswaldo Cruz (FIOCRUZ), the Brazilian recipient of the grant, was able to undertake the task at that time because an earlier phase of the project funded by IDRC and CIDA had remodeled and modernized FIOCRUZ's yellow-fever vaccine laboratories in Rio de Janeiro, and brought its facilities and techniques to approved international standards.

So effective has been the capacity-building exercise in the phase I project that all of the phase II research is being initiated and conducted in Rio with minimal help from visiting experts. It is hoped that this project will help solve such major global problems as the slow growth rate of production of yellow-fever vaccine and the unavailability of the vaccines to infants because current production methods tend to result in dangerous neurotoxic contaminants. The new FIOCRUZ project aims to discover a new production method using tissue culture. During phase I, FIOCRUZ produced vaccines that were more thermostabile than the standard vaccine. Now it is responsible for one of the main examples of innovative biotechnology centered exclusively in a developing country.

In contrast, it is useful to look at the development of institutional capacity in a smaller country, and on a smaller scale. IDRC began working with the Morogoro campus of the University of Dar es Salaam in Tanzania in 1972 and, over the years, it has supported 11 projects in agriculture, forestry, and agrogeology to a total of CAD 2 million. In 1984, the Morogoro campus became a separate entity renamed the Sokoine University of Agriculture. A recent study by the University itself concluded that the Centre had made a significant contribution to building up the research and training capacity of the institution.

Another part of Africa provides another example of the need to maintain project support over a long period. IDRC has been supporting a root-crops program in Cameroon since 1978 — the first project was approved in September 1976 — at a cost of over CAD 1 million. However, when phase III ends in late 1986, the Cameroonian government will be undertaking full responsibility for the management and financing of future research on root crops.

A similar pattern can be noted in a sorghum breeding, intercropping, and grain-preservation project in Senegal. This was the first project supported by IDRC in French West Africa. Previously, the Senegalese research station in Bambey, where the project was located, had been staffed entirely by French scientists. In addition to providing about CAD 1.3 million, IDRC had to provide assistance in the form of advisory groups and financial and administrative guidance, as well as relevant training opportunities. Six years passed before the first trained Senegalese scientist returned to serve the project. However, by the end of phase III in 1982, it had become Senegal's first, major, locally managed agricultural research project. IDRC then withdrew from any major involvement, leaving the field to the Senegalese government with the help of other international agencies.

An easily neglected aspect of capacity building is the management of research organizations. Some Third World research institutions are staffed by scientists who are extremely capable in their field, but who have little experience in administration, planning, budgeting, and inventory control. A Centre-supported project to address this kind of problem in Asia has not only contributed to management training and curriculum development, but has also led research organizations and academic institutions in a number of Asian countries to develop an interest — and to start courses — in research management.

IDRC has provided another, rather special kind of institutional support to five social science research centres in Chile and Argentina. Given mostly for 3-year periods, this support helped these five centres to keep a core staff and "maintain a spirit of inquiry" in a difficult, if not hostile, research environment. The discouraging research environment when the first of these projects was approved in 1977 included a lack of access to funds. At least 90% of such funds as were obtained came from abroad. The idea was to provide encouragement and flexibility while the researchers and managers waited and hoped for the centres to achieve institutional viability and for the research environment to improve. Although several representatives of these research centres expressed appreciation for the funds, they stressed that the psychological boost they received from association with a prestigious international centre such as IDRC was no less important.

How helpful is such support in an environment where, for example, there is little hope that social science research can have any early effect on national policy? The recent political liberalization in Argentina has provided IDRC with encouraging answers to this question. The new democratic government is drawing on the services of those social scientists, some of whom are now in the government itself. It is also beginning to support the research work and use the results in policy formulation.

PRODUCING KNOWLEDGE

The product of scientific research is knowledge, which is intangible and difficult to gauge. One approach to assessing it, however, is to concentrate on the different ways in which knowledge can be used. For example, many projects supported by the Centre have resulted in new research methodologies that are, as a rule, particularly applicable to Third World problems and circumstances. Others have produced results whose value has been established through incorporation in policy or practice at the national, community, institutional, or even individual level. Some projects have generated knowledge in a more tangible sense and have resulted in new products or in substantial adjustments to existing products. Also, some results are worthy of separate treatment because their significance reaches beyond institutional or national borders into a wider community.

PUBLISHING NEW KNOWLEDGE

Many projects produce nothing worth publishing either because they do not realize their objectives or because their outputs are in the area of capacity building. Others produce excellent material that is published in international journals. In some instances, the output of a project may never appear in such publications, either because the research is considered by the editors to be substandard or because the subject matter has little international relevance. Consequently, a paper or booklet recording the results of such research may be the only existing research document dealing with that topic for a particular country. Such material, in addition to its limited distribution, might be published in languages spoken only in specific localities.

Publication and dissemination are frequently essential to the application of knowledge, and support is always available for these purposes. IDRC itself has contributed to this process in numerous ways. It has entered into about 100 "buy-back" arrangements with publishers, by which the Centre agrees to buy a certain number of copies. Under this system, more than 60 000 copies of books and magazines have been purchased and distributed. IDRC has also issued more than 500 publications through its Communications Division and distributes about 100 000 copies annually. These are frequently collections of papers from several projects and it is estimated that the outputs of at least 1000 research activities have been disseminated in this way. More than 700 periodicals, papers, and other publications have emanated from projects backed by IDRC funds.

IDRC has deliberately supported research on important but hitherto neglected problems. Hence the information produced is not merely interesting; it is often unique. The research on tropical timber in the Andean Pact countries is a good example. When these countries decided that the time had come to make optimum use of their abundant and previously wasted or neglected forest resources, there was little scientific material on which to base their policies: virtually all research on forest products had been done in the developed countries. The Junta del Acuerdo de Cartagena — the technical secretariat of the Andean Pact Commission — brought together 11 institutions in five member countries to produce a variety of data on the Andean forests, their potential, and factors impeding exploitation. The project was supported by IDRC and was the Junta's first major research activity.

The scientific base, which has resulted from the work of 200 researchers engaged on this project in 11 subregional laboratories, covers a wide range of subjects (Keenan and Tejada 1984) — the appropriateness of wood as a building material, species identification and anatomy, drying and preservation, and grading. A grading manual, a design manual, and a host of other publications are among the outputs of this project. Although some of the knowledge produced is peculiar to the Andean situation, much is of interest to other countries.

RESEARCH METHODS

Any agency concerned with fostering self-help research has to strike the right balance between accepting the ideas of local researchers about the best way to tackle a problem and proposing alternative approaches that may be better. In the area of research methods, the Centre's program staff are well placed to perform their cross-pollination role, carrying ideas from one project to another, within and among regions. Thus an important output of these endeavours has been in terms of introducing new methods and approaches to research communities and, from the resulting experiences, providing lessons on how research can be carried out effectively.

The case studies from Central America, Indonesia, and Peru in chapters 5, 11, and 13 are examples of what has come to be known as farming systems research (FSR). This is essentially an attempt to improve communication among scientists, extension workers, and the farming community. Too frequently in the past, the approach has been "top down": first, laboratory and station research, then passing the results to the extension services, and lastly the "transfer" to the farmer. FSR makes the family farm the starting point and brings farmers, scientists, and extensionists together as a team. Many agricultural projects supported by the Centre and other international agencies and national governments today use the principles of FSR as a matter of course. Some researchers in the USA have sought the help of their Asian colleagues and of IDRC staff in incorporating this approach into their research in the USA and overseas.

In the area of social science research, the Centre has offered opportunities for experimentation with a wide range of research methods:

"action" or "participatory" research, in which people themselves become involved in trying out some new way of doing something, say, using older children as teachers in a low-cost education system; quantitative approaches to measuring social variables (see chapter 6 on primary-school teachers in Egypt); and qualitative methods that attempt to get round the difficulty of measuring things that are unquantifiable, such as attitudes, by more systematic collection of qualitative information.

Research methods supported in the health field have varied from highly sophisticated clinical work on contraceptive technology to "experimental development," almost the parallel of FSR in that communities become involved in trying out services and products aimed at health care or improvement.

USING KNOWLEDGE: POLICY

Important though the generation of knowledge and the sharpening of methodological tools may be, the ultimate effect on the Third World's development problems is reflected in implementation. Many projects supported by IDRC have begun to have an effect on the policies of Third World governments. Private-sector organizations, cooperatives, and other nongovernmental bodies have also adopted ideas, artifacts, and practices resulting from research supported by the Centre.

Two projects in Latin America, for example, have resulted in new approaches to nonformal education being evaluated and gradually adopted into national educational practice. The first, a rural university project in Colombia, funded by IDRC and other agencies, set out to demonstrate that gifted rural youth with little formal primary education could be brought up to matriculation level in about 2 years (Arbab 1984). In the second project, the independent and prestigious Fundación para la Educación Superior y el Desarrollo (FEDESARROLLO, Foundation for Higher Education and Development), after doing research on conflicts among different levels of government concerned with education in Colombia, was asked to help draft legislation to resolve the problems.

A similar project in Thailand was undertaken by the SVITA Foundation, a private, nonprofit organization. It was based on devolution of responsibility for the assessment of community needs to local councils and on the need, therefore, to strengthen the capabilities of the councils. One outcome of the research was the successful encouragement of combined training programs to reduce conflict and competition among similar development programs aimed at the same audiences. The Prime Minister of Thailand, Prem Tinsulanonda, commended this collaborative approach to the rest of the country. An apparently simple but quite important discovery made by the researchers was that villagers, particularly women, were excluded from many government programs because they were unable to fill in the required forms. An innovative teaching method, using enlarged specimens of the forms, has proved so successful that the Department of Nonformal Education has decided to incorporate the idea into the national literacy campaign. Another outcome was an educational program for local bankers and community women on simplifying credit procedures, and on correcting the bankers' misconceptions about women's ability to repay bank loans. The ultimate aim of this two-pronged strategy was to enable more women to obtain such loans.

More recently, some projects have begun to produce outputs at the level of macroeconomic policy. One such is *Macroeconomic Research (Brazil)* through which IDRC partly funded the specification of a macroeconomic policy model, both for instructional purposes and to simulate the consequences of policy choices.

The model-building activities were carried out by the Pontifícia Universidade Católica de Rio de Janeiro (PUC). One of the outcomes was the development by Professors Persio Arida and Andre Lara-Resende, both of PUC, of a complex and novel scheme to solve Brazil's problem of hyperinflation. Their ideas were summarized in a recent article in the *Economist* ("Bursting Brazil's inflation bubble," 30 March 1985). Professor Arida's subsequent appointment as Special Advisor to the Minister of Planning is tangible evidence that the ideas developed and disseminated by him and his colleague are being taken seriously.

USING KNOWLEDGE: TECHNOLOGY

Apart from the production and use of knowledge in the intangible sense, some research activities have resulted in the creation, or at least the improvement or transformation, of more tangible items — "harder" technology. Some examples in the areas of food and health are given in Table 1.

A pattern of no fixed rules emerges from this experience. Beneficial technology *can* arise from knowledge and artifacts available in developed countries. On the other hand, as someone has remarked, "dropping contraceptives from helicopters doesn't work." The best results seem to come from a happy coincidence of what people need and what is on offer. Frequently, before importing anything to offer, it is wise to start with an understanding of what people need; also, it is usually safer and cheaper to use local materials and skills for manufacture and maintenance.

One piece of hard technology that borrows a little from all of these ideas is a simple machine to take the hard outer coating off small grains, particularly sorghum and millet, before they are ground for flour. The machine is known as the dehuller. Traditionally, the task that it performs is done by women and children pounding moistened grain for several hours a day with a wooden mortar and pestle. An original machine developed in Canada was intended for threshing barley. Later, a prototype dehuller was developed at the National Research Council of Canada's Prairie Regional Laboratory (PRL) in Saskatchewan. It operated on a continuous-flow system and was ill adapted to some families' demand to have their grain milled separately from everybody else's. To solve this problem, a new, smaller model, capable of working either in a continuous flow or with batches of as little as 5 kg, was developed at the Rural Industries Innovation Centre (RIIC) in Botswana. The PRL–RIIC dehuller, as the new model is called, is now being used in more than 30 locations in Botswana (Eastman 1980).

Table 1. Some useful technology arising from IDRC-supported research in developing countries.

Food and Agriculture	
Quinoa in Bolivia	An important food crop in the High Andes — increased production of improved variety and processing plant financed by FAO
Casuarina in Egypt	A useful tree to shelter reclaimed land — better varieties being used by land reclamation companies; seeds being supplied to 10 other countries
Pigeon peas in Kenya	A legume providing protein to the diet — early maturing, higher yielding, and disease-resistant variety in heavy demand
Yams in Cameroon	A root crop providing basic food — better popular varieties are being exported
Sweet potatoes in the Philippines	An important source of food — new high-yielding variety distributed to 60 000 evacuees from a volcanic eruption
Oyster culture in Jamaica	Researchers, producers, and extension workers have developed an economic system that produces oysters in less than 9 months
Bees in Malaysia	Improved systems developed for 30–40 hives per producer — 200 producers have been trained
Cattle feed in Bali	Cheaper feed from coconut, rice, and cassava by-products, plus natural forage — 13 farmers given loans by local banks
Health and Sanitation	
Tri-colour tape in Colombia	A simple device to assess the nutritional status of infants by measuring arm thickness
Handpumps for village water	Designed in Canada, adapted in Ethiopia, Malawi, Malaysia, Philippines, Sri Lanka, and Thailand
Latrines in Sierra Leone	Made from local materials by villagers themselves — "action research"
Contraceptives world wide	Male vaccine being developed, copper-T and subdermal implant improved
Combatting diarrhea	Rural health-care systems and effective use of oral rehydration in Bangladesh and the Philippines

Whereas the original technology for the dehuller was Canadian, the grain storage technique developed in Africa is an improvement by scientists of technology used for centuries by African farmers. The Centre's contribution in this field came at a time when international donor and development agencies were trying to interest African farmers in acquiring a variety of foreign storage devices. These offers included metal silos (which, with the help of the hot African climate, could cook the stored grain), a "do-it-yourself kit" for building small concrete silos with mostly imported material, and containers relying on expensive imported insecticides.

Researchers at Bambey, Senegal, conducted a survey of local storage needs, resources, and practices: of the 700 farm families interviewed, 75% had inadequate storage facilities. However, the researchers learned that, with some improvement, the African silos could work better. They also found that some indigenous plants used in the storage system of some other African countries possessed natural insecticidal properties and that foreign insecticides were perhaps as unnecessary as they were expensive. To make the necessary improvements, Senegalese scientists at Bambey gathered such data as daily changes in the angle of the sun and seasonal changes in the direction of prevailing winds. They were then able to construct drying racks that took advantage of these climatic conditions and that could be built from local materials.

The village handpump developed under IDRC sponsorship is based, like the storage bin, on an old style technology — in this case, a wooden pump used in Europe around the 14th century. However, this handpump project shares with the dehuller the creation of a working design and prototype by a Canadian group with the remaining R&D work being done by engineers, scientists, and thousands of villagers in the Third World.

After laboratory tests in Canada, the U.K., and Asia, a number of the pumps were installed to test popular reaction and to see how they would stand up to normal use. The six countries selected were Ethiopia and Malawi in Africa, and Malaysia, the Philippines, Sri Lanka, and Thailand in Asia (Sharp and Graham 1982). The basic below-ground components — the piston and foot valve produced at Waterloo University in Canada — were used in all the projects. There were various modifications: for example, the Sri Lankan researchers found that in their circumstances a check valve worked better than the foot valve. Researchers were totally responsible for designing the above-ground components — the pumpstands and spigots — for their respective country projects.

The number of small problems that local researchers encountered, analyzed, and solved, although not disproving the validity of imported technology, certainly highlighted the disadvantages of failing to adapt such technology to local conditions. In the words of Lindsey Robertson, a researcher attached to the Ministry of Community Development and Social Welfare in Malawi:

> It's quite a different thing to test a pump in Waterloo, Canada, and to use it every day in Malawi. One of our problems has been with hyaenas chewing the T-fittings and spigots from our pumps. The white PVC [polyvinyl chloride] we use looks like bone — a favourite with them. You can't really plan for that.

Professor Tan Bock Thiam of the University of Malaya calculates that "there is a combined annual market for 29 500–118 000 [IDRC] handpumps for shallow wells" in Malaysia, the Philippines, Sri Lanka, and Thailand (Tan 1982:65). Professor Goh Sing Yau, also at the University of Malaya, has been working since 1979 developing a suitable design and manufacturing process. The project has made 550 pumps for the Ministry of Health in Malaysia, and seven have been sent for trial in Kenya. The University has signed an agreement with IDRC to collaborate further in the widespread commercialization of the pump in the Third World.

Another concern of the Centre has been the development of primary health care (PHC) systems as part of IDRC's contribution to the WHO target of "health for all by the year 2000." Formalizing, integrating, and strengthening the role of PHC workers — nonprofessional medical workers employed mainly in rural communities — is an aspect of this concern. A step in that direction has been the sponsorship of research on PHC workers by the Centro de Investigaciones Multidisciplinarias en Desarrollo Rural (CIMDER, Centre for Interdisciplinary Research in Rural Development) of the Universidad del Valle in Colombia.

One outcome is a range of equipment enabling PHC workers to provide medical services previously unavailable in the absence of professional medical personnel. The best known of this equipment is the "tricolour tape." The CIMDER tape, as it is called, is based on the Shakir and Morley three-colour scale — an earlier attempt to classify children aged between 0 and 5 years as well-nourished, in danger of malnutrition, or malnourished simply by the thickness of their arms. The tape aims to make it possible for parents and local health workers to classify children in this way without the need for expensive equipment, special medical skills, or even literacy or numeracy. Unfortunately, the correlation between the Shakir–Morley and the age–weight scale was only 35% when the former was tested on over 900 Colombian children. Taking the basic idea of this scale, CIMDER elaborated a new tape to measure the nutritional status of children aged between 0 and 6 years. Its reliability (sensitivity and specificity) varies between 78 and 98%.

GLOBAL EFFECTS

Generally speaking, IDRC has tried to fund projects with relevance beyond national borders. Partly because of this emphasis, many projects have had regional or international effects.

The CIMDER tape, for example, has been adopted in countries all over the world. The ideas generated in the yellow-fever vaccine project in Brazil include, for possibly the first time, the use of distilled water as a diluent and the possible manufacture of a vaccine that can be dispensed to infants. Clearly these have global implications. The new contraceptives yielded by the Centre's partnership with the Population Council are as valuable in the North as in the South. The knowledge gained from research into sexually transmitted diseases (STD) is of wide interest, especially in view of current global concerns about STD.

As the description of the cassava network in the next section shows, the investment in research on cassava has produced knowledge of importance at least to the 300 million people in 90 countries for whom cassava is a staple food, providing 8–10% of energy intake. Some of the scientific discoveries have implications for industrialized as well as developing countries. This is particularly true of the findings of a decade of Centre-supported research by Zairian and Belgian scientists on the role of large intakes of cassava in the causation of endemic goitre and cretinism, especially when such intakes are associated with insufficient iodine in relation to the thiocyanate from the cassava (Ermans et al. 1980; Delange et al. 1982). Although most of the cassava imported into Europe is fed to livestock, these research results are still important in the North. Cassava consumption, unless properly balanced with certain other nutrients, can affect the productivity of livestock (Delange and Ahluwalia 1983).

The series of macroeconomic projects in Latin America referred to earlier could also be considered in terms of their global impact. In a period of intense strain on the world financial system, the antennae of borrowers and lenders alike are receptive to new ideas and to news of possible policy alternatives.

One of the earliest projects supported by the Centre fueled a major international debate among academics, economic planners, and political leaders. This study, conducted by the Bariloche Foundation in Argentina, was a deliberate Third World response to the Club of Rome's 1972 study, *The Limits to Growth* (Meadows et al. 1972). The Bariloche study, called *Catastrophe or a New Society*, suggested that too much onus had been put on Third World peoples to slow down their economic development (Herrera et al. 1976). Indeed, it contended that the more privileged section of humanity should reduce its economic growth and channel more resources to overcome stagnation among the rest of the earth's people.

A later initiative, the Energy Research Group, has involved coordinating an intensive international effort directing research to the energy problems of the Third World.

Energy Research Group

The Energy Research Group (ERG), funded jointly by IDRC and the United Nations University (UNU), is a group of Third World energy specialists set up to assess energy research priorities for the Third World. It is an indirect outcome of the United Nations Conference on New and Renewable Sources of Energy held in Nairobi, Kenya, in August 1981. Until then, most of the research on the so-called energy crisis focused on the industrialized countries, although the Third World was just as seriously affected. The then Canadian Prime Minister Pierre Trudeau undertook at the Nairobi meeting to give IDRC an additional grant of CAD 10 million for extra research in this field. The work of ERG is a part of this additional research as well as a prelude to determining more precisely what research is needed. The tasks assigned to the group were fourfold:

- To assess the research capability of developing countries;
- To assess the relevance and accessibility of the research being done in developing countries;
- To suggest research priorities for developing countries; and
- To suggest how resource allocation for research can be improved.

ERG comprises 10 distinguished energy experts, all from the developing regions of the world. This makes it unique among energy research activities funded by the international donor community. The group, which is served by a small secretariat located in Ottawa, meets twice a year. Under its guidance, the secretariat has established an excellent specialized library on energy including 4500 documents. The secretariat has also contacted hundreds of scientists and energy officials in developing countries to learn about energy research and related activities taking place — unheralded for the most part — in their respective countries. More than 1 year was spent in this way amassing a large information base.

ERG also commissioned 103 review papers. Some were regional reviews; others dealt with technical issues. Whereas only a sprinkling of the energy literature had been contributed previously by Third World scientists, about half of these papers were commissioned from consultants in the Third World. For many of them, this was a valuable opportunity to stand back, look at their region's problems, needs, potentials, and activities in this field, and to contribute to the international discussion in this vital area. A few are working on books on the basis of their submissions to ERG.

Already, many of the papers have been published in local, regional, and international journals. Two of the world's most prestigious energy journals — *Energy Policy* in the U.K. and *The Energy Journal* in the USA — decided to devote special issues to the work produced by ERG's consultants.

One feature of ERG's work is the width of coverage as compared to the narrow focus of earlier studies. ERG felt that even the emphasis on new and renewable sources that gave the Nairobi meeting its name and agenda should not be taken for granted. The contents of the Group's report, which it expects to release in 1986, give an idea of the range of topics covered:

- Research and its environment;
- Energy demand: analysis and management;
- Energy conservation;
- Liquid fuels: oils and alcohols;
- Gaseous fuels: natural gas, biogas, producer gas, and hydrogen;
- Solid fuels: coal, charcoal, and biomass;
- Electricity: thermal, hydro, nuclear, and photovoltaic power, and solar thermal electricity from the wind;
- Thermal sources of energy: geothermal and solar thermal energy;
- Motive power sources: wind energy and human energy; and
- Environmental and health effects: acid rain, the greenhouse effect, deforestation, and desertification.

The role played by Third World researchers in ERG's own work and the interest in ERG's activities expressed by governments as widely spread as those of Algeria, the Dominican Republic, Pakistan, and Zambia suggest three other effects: the development of indigenous research capacity, the encouragement of indigenous research policy, and the development of a potentially large and powerful scientific network in this field. At present, the network exists mainly as a mailing list in the ERG data base, at the heart of which are ERG's members and secretariat and their 100 or so consultants. In addition, there are the 150 scientists who provided a total of 500 peer reviews of the 103 research papers. Further, there are also the 150 Third World energy scientists who responded to the secretariat's questionnaire about activities in their countries.

In a way, therefore, the network even now has potential for more enduring links and impact. The members of the group were initially strangers to one another and held widely differing views. As the work progressed, a consensus formed about the place of energy in development and about the most important development goals. The publication of the Group's report is expected to provide a lasting benchmark for the organization of energy research in the Third World.

MAKING LINKS

A researcher working up in the Andes or down in the Kalahari would never transform research effort into global or even communal benefit if operating as a scientific recluse. Such a researcher needs to establish linkages with colleagues in the South and, possibly, in the North; and perhaps with the international development community and research-funding agencies at home. Also, something must connect the labours of researchers to interested (and not yet interested) eyes, and to the ultimate users and beneficiaries of new knowledge. Researchers need also to link their endeavours with the efforts of those who have laboured before and with the latest theoretical and technological development likely to make a difference to the future.

This part of the research "infrastructure" — helping to make linkages — is indispensable both to a sound research capacity and to the achievement of useful and used results. One of the means used by IDRC has been through "networks."

NETWORKS

A network can be likened to a wheel. There is a coordinating mechanism at the centre or hub and connecting spokes radiate out from the hub to the rim, along which are placed the members of the network. They are linked to one another along the rim and to the coordinating mechanism in the centre: the interdependent whole constitutes a network. For present purposes, a network may be said to exist when two or more related projects are deliberately linked by the sharing of information, activities, or resources and through a coordinating mechanism. Sometimes, where no network coordinator is appointed, a program officer performs this role, although for several reasons such an arrangement is hardly ideal. Apart from the work of the coordinator, the mechanisms holding a network together may include conferences, seminars, or workshops; publications or related forms of information sharing; a shared methodology; and the sharing of skills through cooperation in training.

An examination of a sample of IDRC-supported projects suggests that 37% of all those funded by the Centre are part of research networks. If one takes into account the information networks described below, the figure for projects in research and information networks increases to about 40%. Thus, more than 800 projects supported by the Centre belong to a network of some kind. On average, each research network brings together between four and eight project teams, although some also include projects and groups not supported by the Centre. Overall, IDRC has supported about 130 networks, many of which it has helped to create.

The networks based on FSR are among the best examples. The FSR projects are also divided into — and best function as — regional networks. The Andean farming systems network developed informally after the Centre had funded a number of FSR projects in the Andes (Bolivia, Colombia, Ecuador, and Peru). This network exchanges planting material (germ plasm), information, and research results. It meets biennially. The growing popularity and importance of these meetings can be inferred from the fact that 120 participants attended the last meeting although IDRC supported, directly or indirectly, only 17. About 90 technical papers were presented at the meeting.

One network that illustrates well the range of contributions that IDRC wishes to make is based on cassava.

Cassava Network

Cassava is the staple diet of some 300 million people, especially those in the drier zones of the developing world. It stores well in the ground and is often used as a "reserve crop" to fall back on when other crops are in short supply. It is also an excellent animal feed and a valuable source of industrial starch.

Very little had been done to develop the crop until the early 1970s. When IDRC began working with the Centro Internacional de Agricultura Tropical (CIAT, International Centre for Tropical Agriculture) in Colombia to set up a specialized information centre to support cassava research in 1972, it was found that the total world collection of all known research that had ever been done amounted to 3100 documents. It took 3 years to collect them. This number is a fraction of what is produced annually on crops such as wheat or rice. Beginning in 1971, CIDA channeled some CAD 3 million to cassava research through IDRC to the "hub" of a network at CIAT. The network grew from essentially a one-person operation to a global enterprise that now links 40 countries and many hundreds of scientists working on the crop. Reflecting the importance of cassava in Africa, the network has a twin "hub" in Nigeria at the International Institute of Tropical Agriculture (IITA). As an indication of the global activity stimulated, within 10 years after 1971, there had been as much research literature published as there ever had been up to 1971. The program has also trained hundreds of researchers from national institutions in all regions of the world in various aspects of cassava research. Altogether, more than 60 improved varieties resulting from the work of the centres have been released by 16 countries in Africa, Asia, and Latin America.

One of the most prevalent problems afflicting cassava in Africa is a mosaic disease: this has been "attacked" by a "subnetwork" (Fig. 3). The "hub" in this case was the National Research Council's laboratory in Saskatoon, Canada. Around the rim of the wheel were institutions in

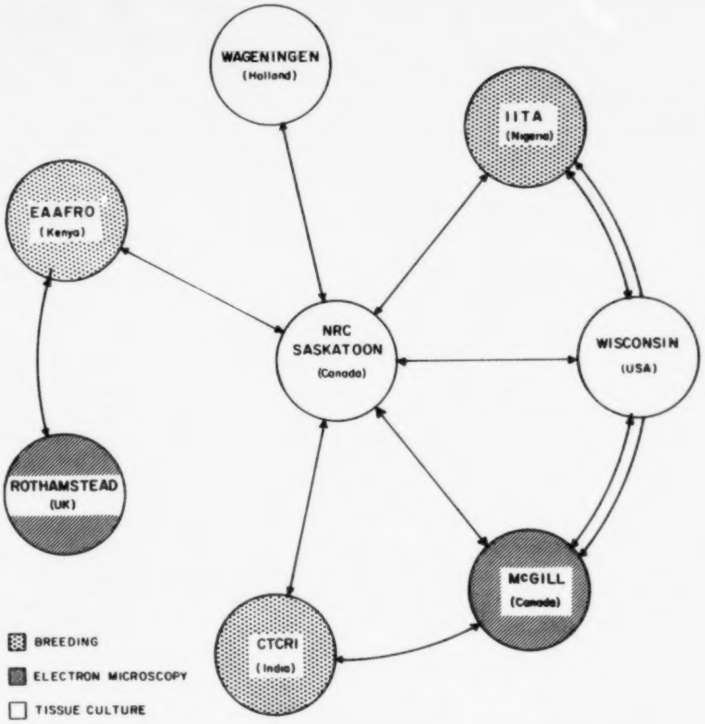
WAGENINGEN
(Holland)
IITA
(Nigeria)
EAAFRO
(Kenya)
NRC
SASKATOON
(Canada)
WISCONSIN
(USA)
ROTHAMSTEAD
(UK)
McGILL
(Canada)
CTCRI
(India)
▩ BREEDING
■ ELECTRON MICROSCOPY
☐ TISSUE CULTURE

Fig. 3. Cassava mosaic research network (from Nestel and Cock 1976).

various countries — for example, Kenya (East African Agriculture and Forestry Research Organization, EAAFRO), India (Central Tuber Crops Research Institute, CTCRI), Nigeria (IITA), and the U.K. (Rothamsted Agriculture Experiment Station). Contacts are made and information flows both from the hub out to the rim and around the rim itself.

The cassava network experience combines many of the features of IDRC's contribution to development through research: managing research funds on behalf of CIDA; supporting international collaboration through the International Agricultural Research Centres (IARCs); identifying those Canadian institutions equipped to deal with specialized areas of research; building research capability in developing countries by supporting formal training and by providing its own funds for specific cassava research projects in national institutions; making information links by supporting the Cassava Information Centre at CIAT and by supporting workshops to bring scientists together physically to learn from each other. In these ways, instead of being marginal and on their own, often missing methods or knowledge held by others, scientists become part of the mainstream of international activity: knowledge and scrutiny of the highest quality is available to them.

INFORMATION AND THE RESEARCHER

Information is a renewable resource: it is not depleted once applied but remains available for further use elsewhere. Obtained at the right time by the right people, it can help to ensure the effective use of other resources. Research produces knowledge. If knowledge is the "message," then information is the "medium": to that extent they are inseparable. A great part of conducting good research lies in not duplicating what has been done before, in picking up from where previous work left off and going further, and in being stimulated and inspired by being aware of past and current work. All of this requires the availability of knowledge through the medium of information.

Information, therefore, has a key role to play in the development process. IDRC acknowledged this by establishing at its inception a major program dedicated to helping developing countries to produce, acquire, and manage information appropriate to their needs: and in recent years this has also meant working to help them produce, acquire, and manage the information technologies needed for this task. One guiding principle of this work has been to help countries to get the best return from limited resources through international collaborative efforts.

Any researcher is now faced with an unmanageable amount of previously acquired knowledge. A useful system will deliver to the researcher only what she or he needs from this store. Because the knowledge is spread through millions of documents, there is a need to obtain the documents and thus many systems are bibliographic. No single institution can control everything and cooperation is consequently essential — usually to produce an inventory of material with a common theme, which may be broad (agriculture) or narrow (cassava). A cooperative system should also ensure speedy retrieval.

Two attempts by the Centre to develop, expand, and support broadly based international cooperative systems were based on the themes of agriculture and of the economic and social aspects of development. The former was covered by AGRIS (the International Information System for Agricultural Sciences and Technology) run by the Food and Agriculture Organization of the United Nations (FAO); and the latter is called DEVSIS (the Development Sciences Information System).

AGRIS aims to collect, record, and make available information about all published works on agricultural research world wide. It is based on a simple concept of country contribution — each country is responsible for putting into the system the research that has been done within its boundaries; in return, it has access to all that has been done elsewhere. AGRIS is divided into regional components: for example, AGRINTER is the regional subsystem through which Latin American countries contribute to and have access to the global data base. In 1974, AGRINTER was a nominal effort: by 1982, it had developed a data base of 100 000 items from all Latin American countries. At that time, IDRC switched the emphasis of its support from the regional to the national level and there are now nine national AGRINTER systems in the region. Strengthening national and regional subsystems has contributed to the growth of the global system: in 1974, entries were measured in tens of thousands, mostly from industrialized countries; now, about 150 000 entries are added each year — about half from the Third World — and the total number approaches 1.5 million.

The contribution to DEVSIS has been similar, with support to regional systems such as PADIS (Pan-African Development Information System) and INFOPLAN (DEVSIS for Latin America and the Caribbean). PADIS is coordinated by the United Nations Economic Commission for Africa (ECA).

In contrast with these subject-specific systems, the Sahelian information network RESADOC (Réseau sahélien d'information et de documentation scientifiques et techniques) is more geographic-specific. Its coordination centre is in the Institut du Sahel at Bamako, Mali. RESADOC has placed great emphasis on building up indigenous capacity to generate, process, and share information to help combat drought in the region. Between 1979 and 1985, 361 persons from the eight member states (Burkina Faso, Chad, Gambia, Guinea Bissau, Mali, Mauritania, Niger, and Senegal) received formal training in various forms. The record on building a documentary data base has been similarly impressive: 4500 documents have been entered in the system. This is supplemented by microfiche collections of nonconventional literature from some of the member countries (5500 documents in total).

Information systems can also be defined by quite narrow subject fields and IDRC has supported Specialized Information Analysis Centres (SIACs) on more than 20 topics, including cassava, camelids, coconuts, ferrocement, geotechnical engineering, packaging, and sorghums and millets. The SIACs were established to correct a situation in which Third World scientists were minimally informed in their respective fields. What information was available — at least in some parts of the Third World — was made available under the old "cafeteria" approach whereby the librarian or documentalist's function becomes one of displaying material for users to choose. Many researchers prefer to have the information pertinent to their particular field synthesized and selected — the time to browse in the hope of finding something of interest is a luxury few can afford. The following comment by an African user of the Cassava Information Centre illustrates the value of the services that a SIAC can provide.

> Experience has shown me that it can be very frustrating trying to get information on any subject in the not-so-good libraries existing in most developing countries. Even in good libraries, it still takes considerable time to go through the various abstracting journals. All this time, effort, and frustration has been eliminated by the Cassava Information Centre.

Another SIAC has been established by the International Livestock Centre for Africa (ILCA) to gather nonconventional information material — limited-circulation mimeographed papers and pamphlets, letters, and memoranda — that constitute much of the scientific knowledge and ideas produced in developing countries. Apart from giving researchers access to such traditionally inaccessible material, this project has the potential of saving the governments of 21 participating countries in sub-Saharan Africa millions of dollars that might otherwise be paid to consultants to produce information that is already available. According to Michael Hailu, Head of Documentation at ILCA, many government officials were amazed at the material found in their own files and desk drawers by ILCA documentalists. Already 10 000 copies — mainly in the form of microfiche — have been disseminated to national research institutes in the 21 countries. After seeing the product, some governments, which originally took 2 or 3 years before reluctantly permitting a search of the files, asked ILCA to return for an extended search.

These are some of the ways in which IDRC has helped researchers, planners, and other groups to gain access to the knowledge that can assist their development efforts. One important dimension to this is gaining access to the most effective technologies for communicating and managing the information. For example, recognizing the increasing availability of minicomputers in developing countries, IDRC developed a powerful and versatile software package — MINISIS (described later). There are now more than 70 MINISIS installations in developing countries. The feature that permits users to interact with the software and manipulate data stored in local languages has made MINISIS a popular and effective tool: this is especially true where there are complex character sets, such as Arabic, Chinese, and Thai.

There is a growing demand by developing countries to design, select, apply, and control information technologies themselves. IDRC has, therefore, expanded its technical advice and project support for designing, testing, and applying new technologies in computer systems, telecommunications, and remote sensing. In collaboration with the Commonwealth Secretariat, for example, IDRC helped finance the development of special software for a computerized debt-management system and then supported its testing by the Government of Sri Lanka. Other projects have examined the feasibility of computer-based conferencing systems for developing countries and have experimented with related techniques for improving the coordination of international research networks. By supporting activities such as these, IDRC is increasing the ability of the developing countries to take full advantage of what the newer information technologies can offer.

MINISIS

Computers offer the capacity to handle large amounts of information quickly and easily. To do so, the computers (hardware) need to be programed and to receive instructions — using programing languages — or software. There are several constraints to making these technological advances available to Third World countries: one is the cost of the hardware; another is that of the language both of the software and of the users in developing countries; and another is the limited ability of systems to handle text — written information — as opposed to numbers. MINISIS is a software package developed by IDRC in an attempt to remove these kinds of constraints.

In the early 1970s, IDRC became very active in the ISIS community as a user and distributor. ISIS is a software package, developed by the International Labour Organization (ILO) and now managed by the United Nations Educational, Scientific and Cultural Organization (Unesco), that is capable of managing textual information and is available free of charge. IDRC used ISIS to automate its own library applications and assisted ILO in enhancing ISIS and making it available to organizations in developing countries. Apart from having to adapt ISIS to deal with the problems of operating in different user languages, the Centre had to deal with the problem of cost. ISIS operated only on a large IBM computer, which was an expensive proposition for the Centre let alone documentation centres in developing countries. Thus, in 1975, the Centre began to design, develop, and maintain a software package that performed basically the same functions as ISIS but operated on a small, much less expensive minicomputer. The resulting software is called MINISIS. Whereas ISIS requires an investment of CAD 500 000 for hardware and a highly trained, specialized team of programmers, MINISIS can operate with an investment of CAD 50 000 for computer hardware and two nonspecialist information workers.

The MINISIS package includes the capability to use multilingual "thesauri" for searching a data base of information. This enables users to locate items that have been described using equivalent terms in different languages. For example, searching for items described by the term "school" would also retrieve items described by the term "école" or "escuela." There are general thesauri of socioeconomic terms used by the Organisation for Economic Cooperation and Development (OECD) and the United Nations. There are more specific ones dealing, for example, with geological terminology or terminology related to camelids (alpacas and llamas). These thesauri facilitate the work of information workers describing items and that of users wanting to search data bases for items described in a language other than that of the original description.

MINISIS does not translate (except in thesaurus form) but can work in a number of languages and in several character sets. Two clerks can work side-by-side using the same computer, the same MINISIS software, and the same data base, one operating in French while the other is working in English. Initially, this capability was limited to languages based on Roman character sets. Later, the capability was enhanced to include other alphabetic character sets such as Arabic, Cyrillic, and Thai, and recently ideographic characters such as Chinese. MINISIS is now used in more than 10 languages around the world.

The development of MINISIS has been shared by IDRC and Third World countries. IDRC has continued to bear responsibility for the integrity of the MINISIS software and to assist Third World countries to build up the technical expertise to solve problems. The countries themselves (and language experts generally) have taken on responsibility for actually developing the additional software required to use MINISIS with specialized terminals and printers that represent their own character sets. The Arab League has developed the Arabic language tools used in MINISIS and distributes these to interested users, mainly in the Middle East.

The statistics suggest that MINISIS represents a major breakthrough in the use of computerized information systems in developing countries and also within the development community in the North. In 1981, the MINISIS network, centered at IDRC's head office, was served by a staff of 15 and had 27 users. At the end of 1985, the same number of Centre staff coordinated the participation of 145 users (licencees and sublicencees) in 41 countries and the network increases by about 30 users each year. More than half the users were located in developing countries — ranging from the National Library in Malaysia, the National Council of Applied Economic Research in India, and the President's Office in Zaire to a regional organization in Trinidad and Tobago and two universities in Chile. Although the service is provided at a reduced rate to developing countries, MINISIS had raised about CAD 1.57 million through commercial distributors in North America and Europe by the end of 1985.

INFORMATION AND THE USER

Although collaboration among researchers is crucial to the research process, the links with the users of the results are also vital. This is particularly true in the case of applied research. In some cases, the policymaker is the appropriate user; in others, extension workers; in yet other cases, the mother, the teacher, the farmer, or the entire populace. IDRC has helped link researchers with various types of users in various ways.

Each quarter, more than 20 000 copies of the Centre's magazines — *IDRC Reports* and the French and Spanish versions, *Le CRDI Explore* and *El CIID Informa* — are distributed, a 10-fold increase in circulation since publication began in March 1974. The magazines have included hundreds of articles based on Centre-supported research activities, although large numbers of science-based and other development articles unrelated to the Centre's projects are also included. About 25% of the magazines' distribution is in Canada, nearly 75% in developing countries. Three special Arabic editions, in 1983, 1984, and 1985, were widely distributed in the Middle East.

The output of Centre-funded research has also generated material for more than 25 films and other audiovisual productions. These films have won six international awards and have been shown on television, at cinemas, and elsewhere to thousands of viewers on all continents. One film — *Prescription for Health* — won the WHO special prize for the best PHC film at the 11th International Festival of Red Cross and Health Films in Bulgaria in 1985. This film is used for training and information purposes by a large number of commercial, national, and international organizations. About 20 language versions — many of them produced or funded by other organizations — are in various stages of completion or negotiation.

Some of the efforts to encourage scholarly publishing by Third World researchers are aimed at improving the dissemination of their research results. For this purpose, the staff of research organizations are taught to use film, videotape, audiocassettes, instructional printed mate-

Fig. 4. Illustration from the booklet on mosquito control in Tuvalu.

rial, brochures, and workshops. Similarly, Third World journalists and broadcasters have been trained and otherwise assisted to communicate with the wider public. Altogether, about 500 persons have received training in or attended seminars, workshops, or conferences on the dissemination of scientific information.

One form of support to wider dissemination with which the Centre has had a limited but growing experience is local-language publishing. One title published by the Centre, *Rice: Postharvest Technology* (Araullo et al. 1976), has been translated into Korean. A "proceedings" on cassava has been published in Thai by the Thai Cassava Producers Association. A book on the processing of legumes has appeared in Japanese.

Respect for language and attention to detail are well illustrated by the Tuvalu mosquito pamphlet. Until 1982, the only book ever published in the language of the 8000 people of Tuvalu in the South Pacific was the Bible. Memorial University in Newfoundland and the South Pacific Commission worked together on the biological control of mosquitoes in that region, and part of their project was an information booklet on malaria: how and where mosquitoes breed, the diseases they carry, their effect on health, and how to control them (Fig. 4). The booklet was written in the local language and distributed to each household.

NORTH–SOUTH COLLABORATION

Cooperation among researchers in the South is only one aspect of IDRC's mandate as a unifying element in the development research community. The Centre has a specific mandate, under the Act, to "foster cooperation in research on development problems between the developed and developing regions for their mutual benefit." The Act also enjoins the Centre's management to "encourage generally the coordination of international development research ...." This latter role is reinforced by the agency's status as the largest aid organization specializing in research on Third World problems. Thus, South–South, North–North, and North–South cooperation are all aspects of the Centre's moral and legislative responsibility.

South–South cooperation predominated during the Centre's first 10 years. Researchers in developed countries, including Canadians, were used sparingly and mainly at the request of Third World recipients. In these cases, the Canadian or other foreign researchers were usually distinguished in their fields, had significant experience in the Third World, and functioned mostly as consultants or project advisors rather than as a researchers. However, more than 100 projects employing Canadian researchers had already been approved before the Cooperative Programs Division was added formally to the IDRC structure. Starting around 1975, the University of Guelph received funding to study the development of microbial protein for stock feed. As noted earlier, the PRL in Saskatoon formed the "hub" of the cassava mosaic network and received funding for research on tissue culture of cassava. In 1975, BC Research, a private institution in Vancouver, was given a grant for research on the production of cheap hormones for the large-scale breeding and hybridization of fish then being attempted under a network of aquaculture projects supported by the Centre in Asia.

In 1980, about 10 years after it was born, IDRC established a special section to encourage and support projects linking Canadian researchers with those from developing countries. The section became a full division in 1983. The impetus for the cooperative programs, as the work of this division was called, came from the United Nations Conference on Science and Technology for Development (UNCSTD) in Vienna in 1979. In fulfillment of a pledge at Vienna, the Canadian government has provided the Centre with additional funds to support this program.

Naturally, the role of Canadian researchers in the work of the Centre has increased significantly since the Cooperative Programs Division was established. During the first 4 years, 114 projects were approved. These projects have linked 500 developing country researchers with 370 Canadian counterparts in 30 Canadian institutions. The CAD 26 million committed by the Centre for cooperative projects have been allocated equally among Third World and Canadian research institutions.

Although only two projects supported by the Cooperative Programs Division have been completed, the potential of cooperative projects to reduce isolation, enhance capacity, and share resources is evident. The *Cyprus Crustal Study* is a case in point.

Cyprus Crustal Study

Marine geology is a relatively new discipline largely confined to a few institutions in North America and Europe. Nonetheless, Third World countries need this expertise to identify and exploit the hydrocarbon and mineral resources located in their offshore regions. The exposed ocean crust in Cyprus, apart from providing developed country scientists with a golden opportunity to learn about "ocean crust geology," also provides an opportunity to share relevant scientific knowledge and technology with developing countries.

The *Cyprus Crustal Study* enabled about 40 suitably qualified geologists from developing countries to obtain training from internationally renowned marine geologists. The training program took advantage of a project involving almost 100 scientists in investigating the structure, lithology, and ore deposits of Cyprus' Troodos ophiolite, the best known and preserved exposed segment of old ocean crust. The Third World geologists spent 6 weeks doing theoretical training and on-site observation in Cyprus. About 65% of them were selected for further laboratory and analytical work in Canadian institutions.

The ophiolite rocks found in Cyprus are relevant to scores of developing countries, many of which have the same type of rocks. The combination of practical work in Cyprus and theoretical work in Canada is expected to enable the participants to reevaluate the ore geology of their countries from the point of view of a new, comprehensive, physically and chemically complete model for ore formation.

Imparting this technology to the developing world has been a truly cooperative enterprise. IDRC helped to finance participation by the Third World geologists, and a number of public and private scientific research foundations from Denmark, the Federal Republic of Germany, Saudi Arabia, the U.K., and the USA also supported the program. Dalhousie University of Canada was responsible for administering the training project.

Already there is evidence that the trainees have acquired and generated a significant amount of new scientific knowledge. By May 1984, the first batch of trainees and their Canadian advisors had collaborated on 26 scientific publications based on their research during the project, and a number of abstracts had been prepared. Several of the papers were presented at a special session devoted to "The Cyprus Drilling Project: Ophiolites" at the May 1984 meeting of the Geological Association of Canada in London, Ontario.

One of the papers prepared for that meeting was by Dr Miguel Haller, a geologist at Argentina's National Geological Service. After the Cyprus segment of the training, Dr Haller did further research at the Centre for Marine Geology at Dalhousie University in Canada with Dr Paul T. Robinson. Dr Haller's study was on the geology and geochemistry of a lower Paleozoic ophiolite from western Argentina. The data gathered during the study suggest that a comparison between the Argentinian and Troodos ophiolites will be of significant scientific interest.

Participating organizations and individuals hope that the project will have a favourable economic impact on participating developing countries: there certainly is evidence that the effects will be long-term. The value of the informal contacts among the participants from the South and between them and their colleagues in the North is real, if immeasurable, but some collaborative research projects have already been developed.

Other Projects

In another project, the Division has linked the Centre international de recherche sur le bilinguisme (CIRB, the International Centre for

Research on Bilingualism) at Université Laval in Quebec with the Language Division of the Office of the Registrar General in Calcutta, India. Researchers from the two agencies are collaborating to produce a list of India's spoken languages. The researchers are codifying the role of each language in such fields as law, business, education, and religion. By early 1985, all the data had been collected and were being processed.

The Centre's funding for the contraceptive research network coordinated by the Population Council is a particularly encouraging example of support for scientific cooperation. The Norplant* contraceptive transplant and the latest Copper T model (the TCU-800), resulting from the research of this network, have been about the only two major contraceptive innovations in the world during the last two decades. Similarly, the Centre has supported research done by the Program for Appropriate Technology in Health (PATH) on a device to indicate when vaccines for measles have become ineffective on account of the tropical heat. The innovation has been tested in several developing countries and used by WHO and by vaccine manufacturers.

Cooperation between the Centre and other aid donors is reflected in both joint programs and joint funding and also meetings and institutions. The cassava network was an example of collaboration between CIDA and IDRC. Having accepted the responsibility to oversee a program of CAD 3 million on behalf of CIDA, the Centre later put several million dollars from its own funds into cassava research. On the other hand, CIDA took over part of the responsibility for financing TECHNONET ASIA, an industrial extension network in Asia, after IDRC funding ended. CIDA also provided funds to the Thai government to set up the National Inland Fisheries Institute: subsequently, IDRC has provided project support for fisheries research. CIDA, whose president normally sits on IDRC's Board of Governors, is understandably the organization with which the Centre has the closest and most regular collaboration. Several other organizations — notably the Canadian University Service Overseas (CUSO), the United States Agency for International Development (USAID), WHO, FAO, and Unesco — have collaborated with the Centre in the development, funding, and monitoring of research programs. The *Cyprus Crustal Study*, for example, was financed by IDRC and seven other organizations.

The Centre has worked particularly closely with the United Nations and other donor agencies on information projects: MINISIS is based on a software package of the ILO and several donor agencies — CIDA, the International Monetary Fund (IMF), USAID, and the World Bank — are among the 145 licencees and sublicencees in 41 countries subscribing to MINISIS. AGRIS is, of course, an FAO data base. DEVSIS, although largely an IDRC initiative, was based on a feasibility study the Centre conducted together with five other international organizations.

IDRC and other international donor organizations have also collaborated on the formation of the newer IARCs. The mechanism for coordinating support for the IARCs is the Consultative Group on International Agricultural Research (CGIAR) — an informal donor network. IDRC was a founding member of CGIAR together with CIDA and the sponsoring United Nations bodies — FAO, United Nations Development Programme (UNDP), and the World Bank. This kind of informal structure has been duplicated in other meetings and groups of research donors. Energy research donors have had two meetings during the past 3 years under the auspices of IDRC. Education research donors, both bilateral and multilateral, from Canada, the Federal Republic of Germany, the Netherlands, Sweden, the U.K., and the USA have also had a number of meetings, including one in Canada with IDRC and CIDA as coorganizers.

CONCLUSION

Research is a means, not an end. Building research capacity, producing new knowledge, and making links are all essential ingredients of the conduct of scientific inquiry. In the context of IDRC's mandate, all these efforts are part of a means to an end — they are for something: research for development.

This sense of purpose has always motivated the Centre to act according to its beliefs. The mission is development and the vehicle is research — research fuelled by four beliefs:

- That real development comes from within societies — hence the concentration of assistance on thousands of people from 100 Third World countries, working in and for those countries;
- That science in the service of humanity should rise above politics — hence the independence given to the Centre by the Canadian parliament;
- That scientific isolation is unforgivable in an interdependent global economy — hence the efforts to make links; and
- That a lean and flexible agency is better able to exploit the gaps left by, and to complement the activities of, the giants in the field — hence the 2000 relatively small projects and the limitation of general management and administration to less than 20% of Centre resources.

However, to borrow some Northern jargon, the "bottom line" is development. Without attempting a rigorous definition, development is to do with people being better off in some way. Although, in richer societies of the world, the extent to which the latest technological gadgetry really makes people better off could be argued at length, in most Third World communities, progress is still needed in areas that few would dispute as being necessary to a feeling of being "well off" — food, water, health, shelter, and education.

IDRC has concentrated on such areas and has reached the stage of maturity where it is increasingly preoccupied with knowing whether the research efforts that it has supported are part of a process that is beginning to touch people's lives. The remainder of this book is devoted to an examination of a number of case studies — research and development stories in which some work supported by the Centre has played a part. Each one looks at two broad questions: what has happened to people — villagers, farmers, teachers and housewives — in that part of their lives to which the research was directed; and how has it happened — what role was played by the research, extension, policy-making processes, and the agencies.

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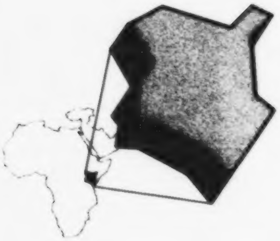
CHAPTER FOUR



THE KENYA CERAMIC *JIKO*[*]

Early in 1982, IDRC funded a small project through its Regional Office for Eastern and Southern Africa in Nairobi. The title was *Testing and Evaluation of Charcoal/Wood Stoves (Kenya)*; the budget was CAD 13 000; the research institution was a small local company called Energy Services Limited. The project involved comparative laboratory tests and field testing of a prototype stove known as the Kimaki Kiln *Jiko*. However, as this chapter makes clear, the project was above all an investment in a person — the principal investor, Maxwell Kinyanjui. The chapter describes the economic benefits that have arisen from the adoption of another type of stove, the Kenya ceramic *jiko*. IDRC does not claim to have been responsible for this development: but it does claim to have provided an opportunity to a key individual at an important stage of his interest in *jiko* making that carried him through to a central role in the process of developing the Kenya ceramic *jiko*.

INTRODUCTION

It is estimated that about half a million households — 80% of urban homes and 10% of those in rural areas of Kenya — use the traditional charcoal-burning *jiko* (the Swahili word for cookstove) (Figs. 1 and 2). The rest of the rural population uses wood as a primary source of fuel for cooking. The idea of using charcoal and fuelwood cookstoves is not new in Kenya. The traditional metal charcoal *jiko* was introduced in the early 1900s by the Indians imported to build the Kenya–Uganda Railway. Used primarily by low-income households in urban and peri-urban areas, it is also fabricated and used in most of the rural towns.

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[*] *This chapter is based on a report prepared by Mutsembi Manundu and Susan Minae of the University of Nairobi.*

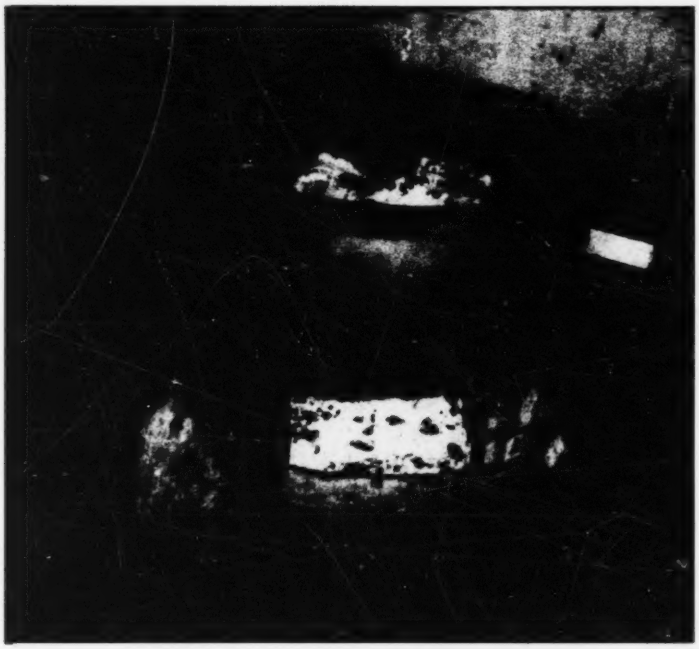


Fig. 1. A traditional metal charcoal *jiko* has an efficiency of 15–20%.

For a long time, Indians dominated the manufacture of the traditional *jiko*. After Independence, however, African artisans entered this sector as the Indians left to pursue investment opportunities elsewhere. Today, virtually all the traditional charcoal *jikos* are made and sold by Africans.

Although fuelwood cookstoves were introduced by Europeans at the time of colonization, their use did not spread to the rest of the population. Consequently, nearly all rural households continue to use the traditional three-stone fireplace (Fig. 3).

The traditional *jiko* is estimated to have a heat-transfer efficiency of 15–20% and the open fire, about 8–12%. It has been shown that it is possible to increase heating efficiency to 30% for charcoal and to 25% for fuelwood cookstoves, thus reducing by as much as 40% the amount of fuel required for cooking. The Food and Agriculture Organization of the United Nations (FAO) estimates that fuelwood needed per person in Kenya could then be reduced from 840 kg/year to 588.

Several factors — apart from cost — are of importance to Kenyan housewives in choosing between different means of cooking:

- Position while cooking — most housewives prefer to sit while cooking.
- Cooking flexibility — some of the cookstoves, such as the Umeme *jiko*, can only be used with pots of specific sizes and shapes. Such cookstoves are, therefore, too inflexible and inconvenient to the user who may have cooking pots of various sizes and shapes.

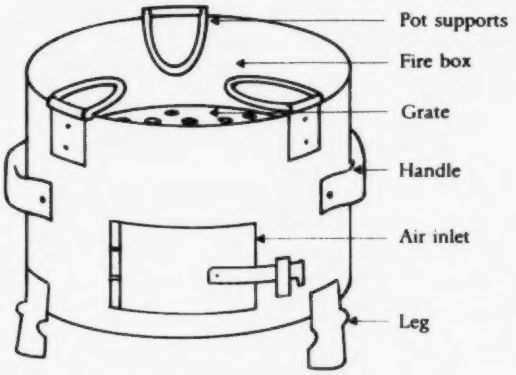


Fig. 2. The traditional charcoal *jiko*.

- Ease of use — ease in lighting a *jiko*, being able to control the amount of heat it emits, and the speed with which it cooks are important. In the case of the portable cookstove, weight is also an important factor: the lighter the cookstove, the better.
- Room heating — in the Kenyan highlands, where the population is concentrated, room heating is essential in the evening. This is a role normally played by the traditional metal *jiko* and the three-stone fireplace.

Fig. 3. A woman preparing *ugali* (maize meal) on a three-stone open fireplace. The three-stone open fireplace uses fuelwood and has an efficiency of about 8–12%.

- Family socialization — some rural households use the fireplace as a focal point to bring the family together.
- Lighting — in rural areas, some households rely on fire to provide light in the kitchen.
- Smoke — although smoke is considered unhygienic, it helps to reduce insect infestation of the roof timbers and to preserve food, seed, and thatch.
- Space availability — small, movable *jikos* have been found to be appropriate in the urban areas, where space is a constraint.

To estimate the benefits from adopting the Kenya ceramic *jiko* (KCJ), it is assumed that urban households normally use the medium-sized traditional metal *jiko*, which costs about KES 35 (CAD 3) in Nairobi (100 Kenyan shillings [KES] = 9 Canadian dollars [CAD]). When used actively, the *jiko* has a useful life of about 24 months, although the grate lasts for only about 6 and costs about KES 5–10 to replace.

If a Nairobi household uses the traditional metal charcoal *jiko*, it uses about two bags or 100 kg of charcoal/month (3.3 kg/day). The charcoal consumption figures in areas outside Nairobi are somewhat lower and differ from one agroclimatic zone to another, depending on such factors as the availability of substitutes for charcoal and their relative prices.

The price of charcoal in Nairobi varies according to manner of purchase (Table 1). Because most low-income households in Nairobi buy charcoal in the form of 20-L tins or 2-kg cans, they spend between KES 145 and 180/month on charcoal — significantly more than they would pay if they bought by 50-kg bags at uncontrolled market prices.

Recent studies on income distribution in Nairobi have shown that about 55% of households are in the low or very-low income category, with a mean monthly income of about KES 1500. The legislated minimum wage is KES 576/month (about CAD 52).

If we assume that the poor of Nairobi spend about KES 162.50/month on charcoal, we would conclude that they spend between 10 and 28% of their total monthly income in this manner — a heavy burden considering that food purchases consume another 35–40% of household income.

Attempts have, therefore, been made to develop an energy-efficient *jiko* that would reduce charcoal consumption while meeting the cooking needs of low-income urban homes. So far, only one design — the

Table 1. Average monthly expenditure on charcoal, Nairobi, 1985.[a]

Unit of purchase	Price per unit (KES)[b]	Price per kilogram (KES)	Expenditure per month (KES)
50-kg bag	60.00	1.20	120.00
20-L tin	9.50	1.45	145.00
2-kg can	2.25	1.80	180.00
30-kg bag[c]	45.00	1.50	150.00

[a] Estimated monthly use is 100 kg.
[b] 100 Kenyan shillings (KES) = 9 Canadian dollars (CAD).
[c] At legislated price.

Kenya ceramic *jiko* — has been tailored to this segment of the population. Indeed, this cookstove has been judged by the Kenyatta University College Unito be the most acceptable charcoal *jiko* to date. It has gained wide acceptance among Kenyan consumers and can now be mass produced. As will be seen, even the few that have been sold and are in effective use have made a small contribution to reducing the depletion of national wood stocks. The improved *jiko* is twice as efficient as its traditional metal counterpart and uses about 50% less charcoal when in good working condition. As most of the urban poor purchase charcoal in small quantities at a time (in 20-L tins or in 2-kg cans), they would spend about KES 81.25/month on charcoal if they used a ceramic *jiko* in good working condition, compared with about KES 162.50/month if they used a traditional metal *jiko*.

The ceramic *jiko* is light and portable, and has two distinct units — a metal cladding and a ceramic liner (see Figs. 4 and 5). The metal

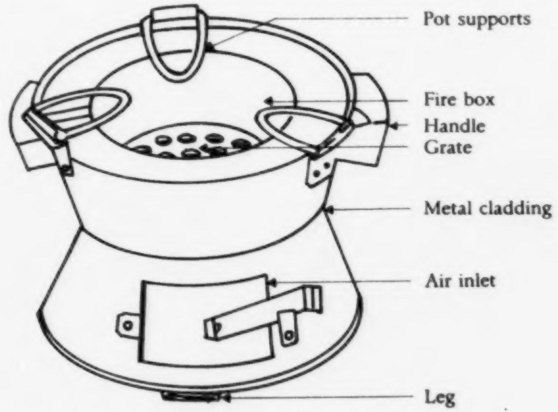

Pot supports
Fire box
Handle
Grate
Metal cladding
Air inlet
Leg

Fig. 4. The Kenya ceramic *jiko*.

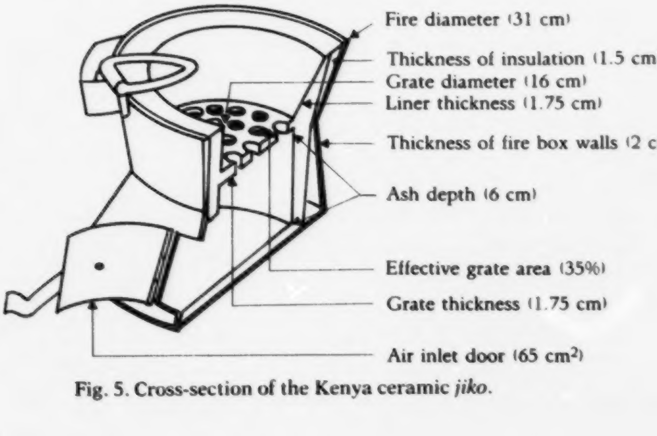

Fire diameter (31 cm)
Thickness of insulation (1.5 cm)
Grate diameter (16 cm)
Liner thickness (1.75 cm)
Thickness of fire box walls (2 cm)
Ash depth (6 cm)
Effective grate area (35%)
Grate thickness (1.75 cm)
Air inlet door (65 cm²)

Fig. 5. Cross-section of the Kenya ceramic *jiko*.

cladding is made by independent local artisans, the ceramic liner by both large-scale and small-scale producers. The large manufacturers in Nairobi are Jerri International, Riruta Jikocraft (owned by Maxwell Kinyanjui), and the Undugu Boys' Centre. Women's groups comprise most of the small producers. The artisans in the informal sector are usually contracted by the large producers to fabricate the claddings. Each artisan can produce five units per day. Assembly of the *jikos* is carried out by large and small operators. An exchange agreement currently exists between some large-scale producers who supply ceramic liners and some small-scale manufacturers who provide metal claddings.

WHAT HAS HAPPENED

More than 181 500 ceramic charcoal *jikos* have been manufactured in Kenya since 1982 and, because demand has exceeded supply, it can be assumed that all have been sold.

Research in Nairobi has revealed several factors that influence the effective use of these stoves. Field tests carried out by the Kenya Energy Non-Govermental Organizations Association (KENGO) indicated that usage of the improved charcoal stove varied from 11% of middle- and high-income households to 91.5% of low-income households that had acquired one. A high proportion of the *jikos* are being bought by the middle- and high-income groups. This is partly because they are still too expensive for poorer households and because publicity for the new *jiko* reaches mostly the middle- and high-income groups. Yet these groups tend to use gas or electricity, or both, to cook. In fact, many of the middle- and high-income households never used the *jiko* after acquiring it. Also, an estimated 30% of the existing stoves are either unusable or are in such a poor state that their efficiency is equivalent to or below that of the traditional *jiko*. It is, therefore, assumed that 125 000 or 70% of all KCJs sold since 1982 are currently in use. However, because they are not all used all the time (Table 2), there are the equivalent of about 68 750 KCJs in effective full-time use in the country.

The life of a stove will depend on how it is handled, used, and cared for. If it can be assumed that this is done equally well (or badly), the main determinant of the useful life of any *jiko* will be the rate of usage. Field tests, together with interviews of households using the improved *jiko*, indicate that if such a stove is used intensively it has a life span of about 30 months. If it is used 50% of the time, it lasts for about 36 months and if it is used about 25% of the time, it lasts for about 48 months.

Table 2. Rate of use of *jikos* in Kenya, June 1985.

Number of *jikos* in use	Rate of usage by households
50000	Most of the time
25000	50% of the time
25000	25% of the time
25000	Hardly used
125000	55% of the time

More than 50% of the ceramic *jikos* in use can be expected to be in very bad condition. Field tests indicated that 64% of the *jikos* sampled had either lost their grates or were equipped with makeshift grates of metal or wire. This had the effect of reducing their efficiency by 25–50%. Thus, instead of assuming the ceramic *jiko* is 50% more efficient than the traditional metal *jiko*, we assume it is only 25% more efficient. This means that an average low-income Nairobi household would be expected to use 75 kg of charcoal/month, costing about KES 121.90. Thus, a household that switches from a traditional metal *jiko* to the improved *jiko* can expect to save, on average, about KES 40.60/month on charcoal, or about 7% of the legislated minimum wage in Nairobi. Assuming a *jiko* has a working life of 30 months, the total charcoal saved over the life of a KCJ by a low-income household in Nairobi would be about 750 kg (or about 15 bags) — a monetary saving of about KES 1218.

Does it pay then, for a household to switch from a traditional metal *jiko* to a KCJ? A medium-sized ceramic *jiko* costs about KES 100 in Nairobi — it is worth noting that Maxwell Kinyanjui sells such *jikos* at KES 65 each, but he is an exception, most others sell their *jikos* at prices ranging from KES 75 to 150. If it is assumed that a traditional *jiko* costing KES 35 entails a cost of KES 162.50/month for charcoal, whereas a KCJ for KES 100 brings charcoal costs down to KES 121.90/month, the ceramic *jiko* will "pay for itself" in 2 or 3 months. At the end of the 2nd month, the KCJ has cost the consumer KES 343.80 (100 + 121.90 + 121.90), whereas a traditional *jiko* has cost KES 360.00 (35 + 162.50 + 162.50). Also, the improved *jiko* lasts about 6 months longer than the traditional *jiko*.

Not only do savings in charcoal consumption offset the higher capital cost of the new stove, but benefits arise at the national level in the form of savings in wood. One KCJ in good working condition saves 25 kg charcoal/month, or 300 kg/year, if used frequently. As noted earlier, the equivalent of about 68 750 KCJ units are in effective full-time use in the country. If each saves 300 kg charcoal/year then 20 625 t of charcoal are saved per year, the equivalent of 206 250 t of wood (or 2% of current wood demanded for charcoal). These savings at the national level translate to about 309 375 m^3 of wood saved per year from an area of about 570 625 ha (5706 km^2).

Although the manufacture of the ceramic *jiko* has not led to significant net gains in income or employment at the national level, it does employ the equivalent of about 530 persons on a full-time basis (6 days/week on average).

HOW IT HAPPENED

The evolution of the national program for cookstove development reflects the growing importance of energy conservation in Kenya and is an interesting example of the interplay of individuals and institutions in the research and development process. Personal interest, charisma, and expertise helped to shape and speed the rate of technology development at the same time as institutions have provided resources, structure, and the environment within which innovation could occur.

Although other people were involved in *jiko* design, this discussion focuses on Maxwell Kinyanjui who played a major role in the whole research and development (R&D) process. Without Maxwell Kinyanjui's driving force, the ceramic *jiko* and Kuni-Mbili *jiko* would still be at a very early stage of testing. By training a physical planner, Maxwell Kinyanjui has had a long-standing interest in land planning and resource utilization. His entry into energy conservation activities, and in particular *jiko* design and development, was by way of a hobby. He describes a time in the 1970s in Nairobi, when a mass electricity failure prompted him to go into town to buy a charcoal stove that he could use to barbecue meat. After driving around for some time, he was frustrated that he could not find a stove that was suitable. When he returned home, he started thinking of how he could make a stove that could be used for barbecuing (grilling) meat but still serve other purposes. Kinyanjui, who received his training in the USA, had already come across barbecue stoves so he thought of how he might improve on those designs and use local materials. He also wanted to design a *jiko* that did not require as much charcoal to cook as the traditional stove, and that concentrated heat at the cooking point. Armed with these ideas, he designed his first *jiko* and had a local *fundi* (blacksmith) make it for him.

This first *jiko* was made mostly of metal. It was spherical and stood on three legs. The lower hemisphere supported a grate sitting on a shallow charcoal box, underneath which was an ash-collecting container; the lid had a conical shape.

The late 1970s was a time of rapid increase in world oil prices. The cost of energy from oil products became prohibitive, especially to nonoil-producing developing nations, and the need to develop energy conserving technologies was of paramount national concern. This evoked widespread interest in the development of efficient cookstoves that could use local fuels such as wood and charcoal. It also aroused interest in exploring ways to increase the efficiency of converting fuelwood to charcoal because traditional kilns have a recovery rate of only about 10%.

Maxwell Kinyanjui, who at this time was a Lecturer in the University of Nairobi, continued to experiment with modifications of the original design. He fabricated a model known as the "Kimaki Multi-Purpose Stove," which he gave or sold to friends. Using their comments and complaints, he improved upon the *jiko*'s efficiency. One desirable characteristic he introduced was that besides using charcoal, the stove could also use fuelwood. As the fuelwood burns, charcoal is formed and it is subsequently used in the same stove. This prototype came to be known as the "Kimaki Kiln *Jiko*."

Staff from IDRC, who had seen the Kimaki Kiln *Jiko* demonstrated at the United Nations Conference on New and Renewable Sources of Energy in 1981, were impressed by the potential of Maxwell Kinyanjui, its designer. He was found to be very knowledgeable and enthusiastic about energy conservation in general and the design and development of more efficient cookstoves in particular. After discussions with staff of IDRC's Nairobi office, Kinyanjui received a grant of KES 85 000 from the Centre to implement the *Kenya Woodstove Evaluation Project*. This would allow him to evaluate the energy-conversion efficiency of the Kimaki Kiln *Jiko* prototype and then improve the model. The evaluation was carried out in Mombasa, where 50 stoves were given free to households for field testing. Part of the IDRC grant was also used to conduct charcoal-making experiments with the Kimaki Kiln *Jiko* and do further experimental work on heat conservation.

Not only did the IDRC funds contribute to design improvements, but the knowledge and experience gained from evaluating and modifying the Kimaki Kiln *Jiko* were also used in the development of other *jikos*. According to Kinyanjui, the grant helped to maintain momentum and interest in cookstove designs and he was able to acquire knowledge and skills through practical experience that enabled him to improve on existing designs and incorporate features important to consumers. He feels that the IDRC grant gave him confidence in his ability to do further work in this area and enabled him to transfer the knowledge and skills acquired into further development work related to the Kuni Mbili and ceramic *jikos*.

The present design of the KCJ is based on the Thai Bucket cookstove and the traditional metal *jiko*. It was developed under the Kenya Renewable Energy Development Project (KREDP) of the Ministry of Energy and Regional Development. KREDP is funded by the United States Agency for International Development (USAID) and implemented by Energy Development International (EDI), consultants to the project. KENGO, which had already organized all the energy nongovernmental organizations (NGOs) into a national forum, was selected as the collaborating institution.

The development of improved cookstoves using fuelwood was initiated in 1982 and led by Kinyanjui who was a consultant with EDI, which was responsible for implementing the *jiko* component of KREDP.

Several studies were carried out to establish baseline data and evaluate existing promising technologies. Several cookstoves that were already in use were tested and existing marketing and distribution strategies and channels were analyzed. It was clearly desirable that the *jiko* developed should be affordable, especially for low-income households. It also had to be socially acceptable, meaning that it should not look drastically different from the cookstoves in use. Local materials and existing facilities were to be used to minimize production costs. It needed to be simple to make and, at the same time, efficient in the use of energy.

After several cookstoves were reviewed, it was agreed that the Thai Bucket offered the best potential as a starting point because it had a relatively high energy efficiency (about 43%) and it could be made from readily available local materials (such as clay). In Thailand, it is made by local artisans using family labour.

In 1982, Kinyanjui and a group of local artisans visited Thailand to study Thai methods of cookstove production and marketing. On their return, the first prototype was made. It consisted of a bucket-shaped metal body, a ceramic liner with vermiculite for insulation, and a ceramic grate. This combination had already been found to give the best performance in terms of fuel economy and stove durability. A ceramic stove (without metal cladding) has a working life of 6–12 months. The metal cladding, therefore, offers protection against cracking and crumbling.

Laboratory tests on energy efficiency were conducted with the help of the Intermediate Technology Development Group (ITDG) at Kenyatta University College. The Kenyan version of the Thai Bucket was compared with the traditional metal stove and the Umeme *jiko* (by the U.N. Children's Fund [UNICEF]) among others. After various laboratory and cooking tests, it was found to reduce energy consumption by 25%. It had a 30% heat-transfer efficiency.

A number of modifications were made to reduce the *jiko*'s weight, increase its durability and stability, and facilitate lighting and handling. Five hundred *jikos* were then produced and field tested for a period of 6 months. A survey of the recipients was conducted to assess durability, performance, social acceptability, and suitability, as well as consumer behaviour related to energy use. The survey was also used to raise public awareness of energy conservation and to establish appropriate marketing systems and pricing structures.

The survey indicated that there were problems with the liners and grates, with lighting, and with size or weight. Overall energy performance, however, was satisfactory and households with working stoves reported reductions of 30–50% in expenditure on fuel.

Further modifications were made in response to the survey, and the current model (Fig. 6) was developed. The top part consists of a tapering metal cladding holding a bowl-shaped ceramic/vermiculite insulator, constituting the fire box, with a built-in fire grate. The lower part is

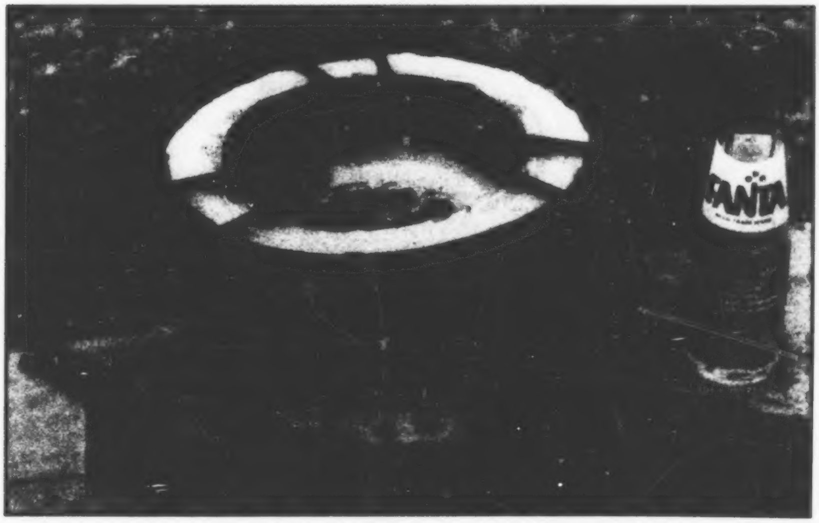


Fig. 6. After it has been assembled, a Kenya ceramic *jiko* is polished and painted black. This stove has an efficiency of 30–40% — the bottle contains kerosene for lighting the stove.

bell-bottomed to make the ash box wider, a feature that has improved the *jiko*'s speed of lighting. The new shape has also allowed the use of a cheaper grade of scrap metal. The *jiko* is usually painted black and, because of its unique shape, looks better than the traditional metal cookstove.

The present model, which has been in production since late 1982, is as easy to use as the traditional *jiko* and is also fairly light, weighing about 3–6 kg. Laboratory tests have shown a heat-transfer efficiency of about 32% and users have claimed to save as much as 50% on charcoal.

It was decided at the outset to teach local artisans to produce and market the new *jikos*. Training is given to those already making traditional metal *jikos* and to potters who make the ceramic liners. After a period of intensive training, some of the artisans are then deployed by NGOs in institutional *jiko* manufacture.

Trainers, extension workers, and instructors in Youth Polytechnics attend lectures and workshops on production and marketing. Most are drawn from the government and various NGOs. To date, it is estimated that more than 30 artisans have been taught how to make the ceramic *jiko*. Some also learn through observation of those who are trained.

Three main types of cookstove producers have been identified: large-scale commercial, independent small-scale, and institutions. Jerri International is the largest producer of the ceramic *jiko*, with an average output of 1000 *jikos*/month. It also produces, on order, small numbers of the Kuni Mbili stove. Riruta Jikocraft, which produces about 500 ceramic *jikos* each month, also makes the Kuni Mbili and the Kimaki Multi-Purpose stoves and is involved in repairing old cookstoves. It is estimated that there are currently about 15 small-scale *jiko* producers falling into two categories: trained artisans and those without formal training. Whereas the large-scale producers are involved in making both the ceramic and metal parts as well as in the final assembly, the small-scale producers generally buy the ceramic liners from the large producers, and make and sell metal claddings for them.

Various institutions have been involved in both the production, demonstration, and distribution of cookstoves — most of them working with women's groups. CARE (Kenya), for example, has been actively involved in many aspects of the Kuni Mbili R&D process: it has a production centre where women make the ceramic liners and the Youth Polytechnic makes the metal claddings. KREDP has demonstration units in its six agroforestry–energy centres. The average production per month for all the centres is about 200 *jikos*.

One of the production problems is the maintenance of quality standards: this is difficult because production facilities are spread around the country. Poor clay mixing and firing procedures, as well as poor assembly practices lead to the production of substandard grates and lower energy efficiency. Supervision is, therefore, required to ensure that producers maintain quality standards and USAID has suggested centralizing the ceramic mixing.

The supply of KCJs has not kept up with demand and production of the ceramic liners has been identified as a bottleneck. However, because producers rarely keep records, it is difficult to determine the actual volume and costs of production.

Achoka Aworry of KENGO believes that mass production of the *jikos* would lower the cost per unit and KENGO has also proposed setting up production units in each district to facilitate marketing and distribution.

THE FUTURE

Most rural households do not seem to realize how much energy is wasted when they use the traditional three-stone fire. Even urban consumers do not appear to be aware that the extra cost of purchasing an improved *jiko* is recovered in only 2 months by its energy-saving potential. This is because the development of most improved cookstoves has relied too heavily on people detached from the ultimate users. The designers have probably been so preoccupied with energy-saving features that they have tended to overlook other characteristics that consumers consider to be important.

As indicated earlier, the number of KCJs in constant use is estimated to be about 40% of the total produced. This implies that many of the *jikos* were bought out of curiosity rather than real need. Our informal survey indicated that the distributors and some of the producer artisans do not fully understand the energy-conservation aspects of the improved *jikos* and are, therefore, unable to explain convincingly to consumers the benefits of the new cookstoves. It is clear that much training is required at this level if the improved *jiko* is to appeal to low-income households — the intended audience — to whom the savings would be most significant.

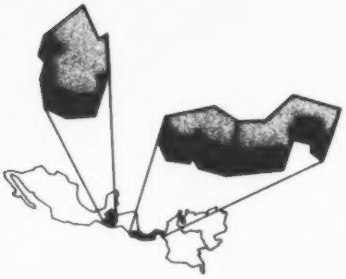
So far, the dissemination process has relied mostly on demonstration, especially to women's groups, in market places, agricultural shows, workshops, and Ministry of Energy and Regional Development agroforestry centres. Efforts have also been made to promote the ceramic *jiko* through such media as newspapers and television. Unfortunately, the number of low-income households — the target audience — that have access to a television set and read newspapers is not yet large enough to make this an effective strategy.

Moreover, the price of the ceramic *jiko* — KES 100–150 — appears high to a family earning KES 576/month (the legislated minimum wage) or less, even though it is low in relation to fuel costs. In contrast, the traditional metal *jiko* sells for KES 35. Poorer families are, therefore, likely to opt for immediate savings even if it means higher charcoal consumption in the longer run. If prices could be lowered, the rate of adoption of the ceramic *jiko* among the urban poor would rise considerably and this would lead swiftly to a significant decline in demand for charcoal.

An additional problem is that the ceramic grates — costing about KES 20 each — have to be replaced frequently because they tend to crack and crumble with a few days or weeks of use because of poor quality control. This, in turn, discourages people from using the improved *jikos*. Indeed, there are cases where users reverted to the traditional metal *jiko*. If people are to be expected to make a permanent switch from the traditional metal *jiko* to the improved ceramic *jiko*, the Ministry of Energy and Regional Development and other organizations interested in the dissemination of the ceramic *jiko* must act to ensure that the ceramic liners and grates coming onto the market are of high quality.

Adequate quality control coupled with effective marketing would not only benefit consumers, particularly the urban poor, it would also lead to further savings in wood at the national level. Even the savings estimated to date of 2% of Kenya's wood consumed in the form of charcoal amounts to 309 375 m^3 in 1985. Saving this amount of wood would mean not having to plant 570 625 ha, or not having to invest between USD 342.4 and 570.6 million annually (using the rate of USD 600–1000/ha from some World Bank projects). Indeed, for this amount of money, good quality ceramic *jikos* could be produced and given free of charge to all households in urban and peri-urban areas of Kenya!

CHAPTER FIVE



ANIMAL PRODUCTION SYSTEMS IN CENTRAL AMERICA*

This chapter is distinguished from the others in that it focuses on the research activities of a regional organization — the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE, Tropical Agricultural Research and Training Centre). CATIE is based in Costa Rica and works with the national research institutions of Central America to increase food production and rural incomes. Between 1977 and 1985, IDRC allocated CAD 967 000 to two phases of research on animal production systems at CATIE. The first phase aimed at developing crop–livestock production systems, especially those using agricultural by-products as animal feed, and the second phase concentrated more on production systems for dual purpose (milk and meat) cattle for small- and medium-sized farmers. Research relating to livestock, especially cattle, tends to be long term because production cycles are measured in years rather than months. However, not only have useful results been obtained but they are also beginning to affect production and incomes in Costa Rica, Guatemala, and Panama. It is not possible to apportion the "credit" for these development effects among the farmers, credit and extension agencies, and national and regional research agencies. It would be even less feasible, within the research effort, to attempt to recognize the contributions of the various donor agencies. All have played a part — and IDRC continues to play a supportive and catalytic role in this important area of development through the wider Latin American Livestock Systems Research network that it has sponsored since 1981.

******This chapter is based on a report written by B. Quijandria, Site Research Coordinator (Small Ruminants), Ministry of Agriculture, Lima, Peru.*

THE SETTING

Low-income, subsistence farmers are common in the agricultural sector of the six countries that make up the Central American Region: Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama. Nearly 28% of the region's rural population is landless and 76% of farms occupy only 6% of all farmland. About 92% of farmers own less than 35 ha, located mostly in areas of poor soil and difficult topography. It is estimated that 67% of farms cover an area of 0.1–4 ha and yield a per-capita annual income of USD 49. A further 25% of farms, ranging in size from 4–35 ha, provide an estimated annual per-capita income of USD 172. In general, the poorest and least adequately nourished farm families make up more than 76% of the region's 10.2 million farm population.

Livestock production is common on the small farms and dual-purpose (milk and meat) cattle are raised on about 75% of them. Milk and beef yields are low, however, due to lack of knowledge and primitive techniques. Throughout the region, there is a gap between the supply of and demand for dairy products. Demand reached 2.5×10^9 L of milk in 1980, for example, whereas local production was only 1.6×10^9 L — a shortfall of 36%. This situation has been partially solved through imports of milk products at a cost of USD 70 million/year. With the population of the Central American countries, except Costa Rica, expected to grow by 2.7–3.3% annually, however, the gap between supply and demand will grow even wider and the cost of imports will rise.

It is in this setting that the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE, Tropical Agricultural Research and Training Centre) has undertaken, since 1977, the task of generating appropriate technologies for dual-purpose and milk production systems for low-income, subsistence farmers of the region. CATIE works in association with national institutions for research and development, and with the financial backing of the governments of the region and of donor agencies such as the United States Agency for International Aid (USAID) through its Regional Office for Central America (ROCAP), the Interamerican Development Bank (IDB), and IDRC.

FROM RESEARCH TO DEVELOPMENT

The purpose of production systems research is to generate alternative technologies with a view to improving the performance of existing systems, thereby enhancing the well-being of peasant families.

Production systems research would not be useful, however, if its results were not translated into a sound, appropriate development program. In Costa Rica, Guatemala, and Panama, three of the Central American countries in which CATIE and national research institutions have launched animal production research projects with the support of IDRC, ROCAP, and IDB, the initial findings have moved governments to initiate development programs designed to raise the living standards of subsistence farmers and to increase milk supply to local and national markets. These cases are discussed here.

GUATEMALA

In Guatemala, CATIE's research activities were carried out in association with the Instituto Nacional de Tecnología Agropecuaria (INTA, National Institute of Farming Technology). A dual-purpose or milk-production prototype was established in 1979 on land INTA owns in the Nueva Concepción area. The land is typical of the area, where 80% of all farmland is devoted to dual-purpose livestock production. During the process of generating the improved model, 11 farmers participated in a continuous survey and four established the model.

The results of this research convinced the agricultural authorities that an extension and credit effort would have a significant impact on milk production and farm income. It was estimated that milk production in the area could be doubled, from 30 000 to 60 000 L during the dry summer season and from 52 000 to 104 000 L during the rainy winter season.

Nueva Concepción accounts for 5% of total national production. With the implementation of a research, extension, and credit program, it was estimated that the area's share of national production could reach 12%.

Implementation of this research, extension, and credit program in Nueva Concepción has been delayed, however, by the institutional obstacles normally encountered in Latin America. Limited public funds are a further impediment to the inclusion of a large number of farmers in the program. To date, 21 farmers have received credit and extension support and it is planned to include 200 producers in the program. Some 3660 families can be involved in the process of increasing milk supply in Guatemala. Official INTA figures indicate that a dairy development plan covering 3360 plots occupying a total area of 96 944 ha on the southern coast of Guatemala could reduce the shortfall in milk supply by 20–30%.

INTA has presented a proposal to IDRC to develop appropriate dairy production technologies in various areas on the southern coast of Guatemala. This initiative would permit INTA to continue the process of generating new technology and validating that already developed in Nueva Concepción. The IDB is also considering ways to increase the credit available for this type of program.

Although the transfer of new technology on a large scale is still in its initial phase in Central America, governments have taken the necessary steps to complete the final phase of extension and credit assistance to small farmers. Information generated during the research process guarantees at this stage that the improved models will increase milk supplies and raise the incomes of small farmers.

PANAMA

In Panama, as in Guatemala, the process of applying research results to farmers in integrated development programs is already taking place. An extensive area of Panama is devoted to dual-purpose cattle production and accounts for 88% of the country's total milk output. The potential to increase milk supply has been documented and, to date, 100 loans to medium- and small-scale farmers, worth a total of USD 3 million, have been approved. Substantial support is available through a large number of technicians and extension and credit officers.

Agreements between CATIE and the Instituto de Investigación Agropecuaria de Panamá (IDIAP, Panamanian Institute for Agricultural Research) and between IDIAP and IDRC have been supporting the generation of appropriate technology for small farmers for production systems for milk and dual-purpose livestock.

An increased yield of 2 L of milk per animal per target farm is feasible, providing an estimated 80 × 10^6 L of milk annually to the market. However, institutional and economic obstacles similar to those mentioned for Guatemala limit the impact of dairy development programs. As well, a general policy of importation, coupled with political controls over milk prices, tends to discourage local producers from increasing output.

COSTA RICA

Costa Rica probably has the most developed structure for dairy production in Central America. Farm investment and income are the highest, and dairy areas are more specialized and produce higher milk yields. A better-than-average milk-pricing policy and an adequate processing and conservation infrastructure have helped the country to maintain adequate production levels and supplies.

CATIE tested its dairy production model in three areas of Costa Rica between 1977 and 1982 through an agreement with the Instituto de Tierras y Colonización (ITCO). Validation of the model has been documented in several reports, and the transformation of a state-supported group of farmers in the tropical areas of Costa Rica into dual-purpose or specialized milk producers was successfully accomplished.

One area, Rio Frio, with an estimated production of 400 L/day — barely enough to meet local needs — reached the point where marketing channels had to be upgraded, a cooling station installed in the area, and a special agreement established with milk-processing cooperatives. A total of 10 000 L of milk/day was reached, supplying not only the area, but also the main milk market in San José. That experience was repeated successfully elsewhere. An increase of 50% in cultivated forages was obtained and, at the same time, an increase in livestock population occurred, with dairy cows increasing from an average of 10.5 animals/farm at the outset of the project to 23.5 at the end. Data from Rio Frio for 1979 and 1984 show significant increases in gross family incomes and a marked fall in reliance on government subsidies.

The initial objective of the ITCO–CATIE agreement was to validate a specialized dairy production system. Upon completion of the project, producers adapted the validated technology to dual-purpose systems: over 80% of farmers were found to have shifted to dual-purpose production.

The Ministry of Agriculture and Livestock in Costa Rica has launched a dairy development program and requested financial assistance from IDB. It is expected that, by 1986, a strong extension and development program will be in place using the technologies developed by CATIE.

CATIE'S ANIMAL PRODUCTION DEPARTMENT

CATIE was created in the late 1940s by the Organization of American States (OAS) as a centre for postgraduate training and development research for Latin America. It was initially affiliated with the former Instituto Interamericano de Ciencias Agrícolas, but is now sponsored by the Instituto Interamericano de Cooperación para la Agricultura (IICA, Inter-American Institute for Cooperation on Agriculture) and an association of Central American governments. Although CATIE is financed by these institutions, it relies to a large extent on financial support from international donor agencies for specific research and development projects.

In 1973, the staff of CATIE's Animal Production Department developed the concept of milk and beef production systems (MBPS). This means self-contained, low-investment, simple-management, milk-and-beef production systems for small farmers. The idea was to treat MBPS as a system or model that could be used as an integrated unit in research and extension efforts.

To that end, and in line with CATIE's postgraduate training orientation, thesis research was directed to several components of milk and beef systems, including features of grazing systems, forage and nutritional supply, and genetic and management aspects of an integrated system. The combined results were put together in CATIE's "Dairy Module" — the conceptual base for the development of self-contained dual-purpose or milk-production systems for small farmers.

CATIE's dairy module has been tested and perfected over the years and its biological and economic benefits demonstrated through several research trials. Income derived from milk production in this type of module has been considered adequate to maintain an appropriate living standard for a subsistence rural family.

CATIE's experience in livestock production systems for low-income farmers constituted an appropriate tool to increase the income of the region's poorer farmers. Since 1977, three research projects have obtained financial support from international or local financial institutions. The first was sponsored by IDRC and was devoted to dual-purpose livestock production systems. Two additional projects in dairy production systems and subsistence farmers' production systems were sponsored in 1979 by ROCAP and IDB. At the same time, CATIE negotiated validation, extension, and development programs with national institutions in Costa Rica, Honduras, and Panama.

Programs and projects were devoted primarily to the generation of appropriate livestock production systems for small farmers, but also dealt with the training of local professionals and the strengthening of local national institutions. This range of agreements gave CATIE and its

Animal Production Department a regional presence, with high-level professionals residing in the six Central American countries, and a network of training courses and programs (also supported by the Kellog Foundation) promoting the development of livestock research in host countries. This research network provided an ideal setting to generate technology, gather information on traditional small-farmer systems, validate tested technologies, and promote development in several livestock-producing areas.

GENERATION OF TECHNOLOGY: ANIMAL PRODUCTION SYSTEMS RESEARCH

CATIE's initial attempts to develop appropriate livestock production systems for subsistence farmers showed the difficulties encountered in this type of research. An extended biological period required to evaluate the effect of changes in traditional technology was one of the first constraints. Lack of sufficient information related to the performance of traditional systems also limited the capacity to introduce alternatives to small farmers. Finally, the small number of farms involved in the process of generating and validating technology limited the generalization of research results. All these constraints had to be confronted on highly variable types of farms within given regions.

For many of the production systems research projects initiated in Central America by CATIE and national research institutions, the methodology utilized included

- Selection of target areas based on criteria that permit maximum effectiveness of research and optimal use of resources;
- Characterization of traditional farming systems with a view to understanding the factors that constrain production and productivity;
- Synthesis of an improved model;
- Research on the components;
- Validation of improved models under farm conditions;
- Adjustment of the improved model; and
- Transfer of the model to small farmers.

SELECTION OF TARGET AREAS

Throughout the Central American region, CATIE conducted a thorough evaluation of the potential of several regions within every country to select target areas. A substantial collection of secondary and census information was completed, and quick surveys were carried out in the six countries.

The criteria used by CATIE and the national research institutions to rank the most important livestock-producing areas included national priorities, presence of national research institutions, concentration of subsistence farmers, uniformity of production, potential for biological and socioeconomic improvement, representativeness of agroclimatic regions, road networks, and presence of markets. Sixteen target areas were selected in the six countries.

CHARACTERIZATION OF TRADITIONAL FARMING SYSTEMS

The process of describing the traditional farming systems is one of the most important steps in livestock systems research. Its objectives are to identify and describe the main geographic, ecological, and socioeconomic characteristics of the target area; traditional farming systems; factors that affect production and productivity; productive or potentially productive resources of the target area that can be included in improved systems; attitudes, motivations, and goals of subsistence farmers; and, finally, to delimit the boundaries within which technical improvements will prevail and establish component research priorities.

Information required to select target areas and that arising from the characterization process provide a critical evaluation of traditional farming systems as well as a basis for in-depth studies of small-farm conditions and a useful tool for planning development programs.

The characterization of target areas is normally conducted in three stages. The first is a quick survey consisting of short visits and interviews with key persons from the area. The second is a static or "one-shot" survey consisting of a formal questionnaire directed to a sample of farmers covering 2–10% of agricultural units within the area. Where farming systems are uniform, a smaller sample will suffice but as variability in farming systems increases, a larger sample will be required.

The third stage in characterization, and probably the most useful, is the so-called "Dynamic Survey," also known as farm monitoring. Because farm monitoring covers activities spanning several years, it provides a very good indicator of the responses of traditional farming systems to climatic variations. The stratification of farmers, the diversity among small farms, and representativeness of microregions within the area are factors to be considered in the sampling process. Because farmers' cooperation is fairly variable, selection does not always follow a randomized process, consequently the statistical techniques available to analyze the results are limited.

CATIE and the associated national research institutions conducted the characterization process in each of the selected target areas, and a wealth of information was collected on farming systems in the region. This information should be updated periodically because it constitutes a useful tool for planning research projects, development programs, and policy measures in the Central American countries.

The concept of a whole-system approach permits alternatives to be designed that will fit within traditional practices without disrupting mechanisms that already function. The degree of alteration of a traditional livestock system will depend on the number of constraints, known technologies, and capacities to modify the system. The synthesis process would normally indicate those areas in which existing knowledge does not suggest ways to overcome impediments. During CATIE's experience in Central America, a wide variety of improved systems were designed. The main limiting factor — nutrition — was addressed through several technological improvements designed to improve nutritional supply in quantity and quality within and among years.

COMPONENT RESEARCH

Component research is a source of the technological innovation required to overcome the biological constraints of traditional livestock production systems. The type of component research undertaken will depend on the nature of limiting factors and the type of problem addressed.

Component research can be exploratory (introduction of varieties or species of forages), analytical (levels of fertilization or carrying capacity), or oriented to validation (use of mineral salts or selection criteria).

Although CATIE's Animal Production Department has a long list of technological achievements, it is only within the last decade that a set of experiments was carried out under the systems research methodology to respond directly to limiting factors or constraints identified during the process of characterization and design of alternative or interventional livestock models.

The IDRC-sponsored *Dual-Purpose Livestock Production System Project* played a leading role in terms of component research. Several areas of research were included to describe actual systems better, to explain the interrelation of input to output in livestock systems, and to validate existing knowledge under small-farm conditions.

Surveys and diagnostic studies conducted in Costa Rica by the IDRC-sponsored CATIE project and all over Central America by ROCAP and IDB projects indicated that the most pressing limiting factor was the variation in supply of feedstuffs within and among years. In many cases, milk production and raising of young animals came to a halt during the dry season or in dry years but feed supply during the rainy season normally exceeded the consuming capacity of existing animals. Coupled with these problems, sanitation, management, genetic composition of herd, and economic use of resources were additional factors limiting production and productivity under small-farm conditions.

Priorities developed from survey results helped to establish the appropriate lines of component research to which CATIE and national institutions devoted their efforts. On this basis, a group of research experiments were conducted to solve the critical problems of livestock nutrition. The main areas addressed in the search for solutions to nutritional problems have included forage and crop-residue productivities; forage conservation; evaluation of forage germ plasm; evaluation of chemical composition, digestibility, and voluntary consumption of forages; nutritional physiology; alternative use of crop residues and by-products; and methodologies in nutrition research.

Graduate thesis research and nonacademic experiments have probed many of the nutritional factors related to livestock production systems. Several studies have addressed the use of crop residues and agricultural by-products as potential feed sources. Rejected bananas, cassava forage, sweet potatoes, corn stalks, banana pseudostems, bean residues, and other potentially usable agricultural by-products have shown a capability to sustain either growth or milk production under experimental conditions, thereby showing the potential for incorporation in small-farm livestock systems in many areas of Central America.

Intensive grazing systems, biomass production from grasses, forage conservation, and evaluation of commonly used forages, such as African star grass (*Cynodon nlemfuensis*), have been an important part of component research.

Herd and nutritional management and basic aspects of livestock nutrition under tropical and small-farm conditions have also been investigated. Incorporation of either crop residues or forages into livestock production systems and the comparative efficiency of digestion of starch and sugars coming from different crop residues and by-products have been the subjects of several reports. The economic aspects of nutritional technologies or integrated livestock production systems have been evaluated in light of the capacity of the technologies to improve traditional systems.

It is fair to state that a substantial increase in knowledge has been obtained through a decade of research by CATIE. In many cases, the results of field trials presented in this section can be incorporated into animal production systems for small farmers with a large measure of success. Because many of the projects are short, however, the on-farm validation process has not yet been completed. Nevertheless, this pool of information constitutes a substantial resource for researchers working on livestock production in developing countries. Moreover, the process in which innovative technology is generated has enough checks and balances that permit those alternatives that are not applicable to small-farm conditions to be weeded out.

VALIDATED ANIMAL PRODUCTION MODELS: APPROPRIATE TECHNOLOGY FOR LOW-INCOME FARMERS

As mentioned earlier, the objective of animal production systems research is to generate improved models in which management, nutrition, genetic, sanitation, or economic factors are modified and to link them to the traditional farming system to remove elements that restrain or limit production. The general idea is that an increase in net income from farm activities will enhance the well-being of the rural population.

Validation of improved models under farm conditions is a test in which a representative sample of farmers alter their systems and manage the technological alternatives with or without assistance from researchers. The purpose of this activity, which must be carefully monitored, is to evaluate biological, economic, and social responses to the improved model. In many cases, a comparison with traditional systems is carried out over a given period to provide baseline or control elements for the improved model. During the validation process, some measure of acceptability of selected technologies by small farmers should be made to help forecast the impact of given technologies on a wider scale. This stage should be conducted with the help of extension and credit agents, who will understand the basis of the improved model for future activities.

CATIE and national research institutions in Central America have reached the stage in systems research where interventionist technologies or improved models have been developed and validated under small-farm conditions after the selection of target areas, identification of constraints, and utilization of existing knowledge and the results of component research.

ADJUSTMENTS TO THE IMPROVED MODEL

After a suitable period, the improved model should be evaluated biologically and socioeconomically and compared with the traditional systems. An appropriate economic evaluation should indicate investment levels, input requirements, and net returns, and an evaluation of the social acceptability of the full model or individual components should indicate reasons for the rejection of technologies that might have biological benefits yet are unacceptable to the farmer. The evaluation of these factors will provide the basis for final adjustments in the economic and biological structure of the model.

The process of validation is well documented in Costa Rica, Guatemala, and Panama. Improved milk production models for Monte Verde in Costa Rica, for Nueva Concepción in Guatemala, and for the Bugaba area in Panama showed impressive results.

The land needed for the Panama model totaled 16.2 ha, of which 98% was devoted to rotational grazing and the remainder to two legumes as protein banks for calves and milk-producing cows. Infrastructure was limited to fences, pens, feeders, a milking parlour, etc. The total investment was USD 21 109, of which two-thirds — USD 14 336 — was spent on 34 animals, including 16 milking cows. The biological evaluation over a 2-year period indicated increases in carrying capacity, calving percentage, and milk production and a reduction in mortality. The economic evaluation indicated a 16% rate of return on investment and a cost–benefit ratio of 1.2 : 1. It was estimated that the investment would be recovered in 11 years.

The Costa Rica model showed a 21% rate of return and 7 years to recover a total investment of USD 12 850. Livestock accounted for USD 7220 of this amount, and the area required for milk production was 8.5 ha, of which 80% was devoted to grazing and the remainder to cut-and-carry grasses for the dry season. This alternative model also explored the potential of sugarcane and banana pseudostems as forage. The biological evaluation indicated a carrying capacity of 2.1 Livestock Units/ha, a calving percentage of 70, and average daily production of 7.2 L of milk/head. (Livestock units, LUs, are based on cattle.)

In the Guatemala model, the rate of return on an investment of USD 25 083 was 22%, the cost–benefit ratio was 1.57 : 1 and 5 years were required to recover the investment. The system included 60 animals, of which 29 were dairy cows, valued at USD 19 016. The land area was 10.4 ha with 57% devoted to grazing and the remainder to grass or sugarcane mixed with *Leucaena leucocephala* as a silage for the dry season.

In general, animals account for the largest proportion of investment in the three systems. Consequently, if farmers already own the animals, the funds required to improve the traditional system are not too great. It should also be noted that mineral supplementation is a permanent innovation in all improved models designed for Central America.

In the final stage of CATIE's animal production research projects in the region, the improved and traditional models were compared over time. In Bugaba, Panama, increases in the calving rate and milk yields were noted. Although the estimated investment for the traditional system was USD 18 573 against USD 20 270 for the improved model, the net return per hectare for the latter was considerably greater. The net return on investment for the improved model was 23%, almost twice that of the traditional model (12%). Equally, the period required to recover the investment dropped from 11 years in the traditional system to 6 in the improved one.

In Nueva Concepción, Guatemala, three systems were compared — an improved model managed by researchers at a demonstration unit owned by INTA, an improved model managed by the farmer, and the traditional system. As expected, the first was the most productive and the last the least. The carrying capacity increased from 3.0 LU/ha in the traditional model to 4.0 and 5.7 in the improved farm and research models. Similarly, milk production increased from 1449 to 2223 and 3739 L/ha. Net return on investment was 9.6% for the improved system managed by researchers, 5.3% for the improved system managed by farmers, and 3.3% for the traditional system.

TRANSFER TO SMALL FARMERS

After an improved model has been validated and adjusted, it should be diffused or disseminated to extension agencies or to farmer groups within the target area to promote widespread adoption. Credit agencies should also be made aware of the biological and economic advantages of improved models so that they can be included in their credit programs.

CONCLUSION: LOOKING TO THE FUTURE

Research, and particularly systems research, is a continuous self-sustaining endeavour. Diagnostic activities and farm monitoring continuously identify constraints and conditions that call for appropriate remedial technologies. The process of validating improved technologies is also a continuous one, in which a research system provides technological alternatives to extension services, which will later deliver them in their final form to farmers. This system constitutes a mechanism by which research responds to farmer needs and extension agents provide feedback within the system.

Among the lessons to be learned from CATIE's experience in Central America are those related to the duration of the project. Livestock research is, by its biological nature, slow. Component and validation research require long periods to complete and the subsequent biological and economic evaluations require at least 2 years to produce valid results. Projects initiated in the area of livestock systems research should have at least 6 years of assured operation to complete the process of generating technology and validating it on the farm.

CATIE and associated national research institutions have had a fruitful experience since 1978 in developing improved dual-purpose and milk-production systems for small farmers in Central America. In the process, a large amount of valuable information has been gathered and traditional livestock production systems are better understood.

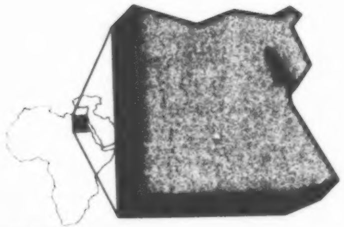
The identification of factors limiting production has made it possible to focus clearly on the research needs of the region, and research on nutrition in particular has produced a significant number of new technologies, evaluated potential resources, and formulated recommendations concerning the management of existing ones.

Improved models have been designed and some of them tested over time using the traditional farming system as a control. However, only IDIAP from Panama and INTA from Guatemala, with the support of IDRC, are continuing the process of generating and validating improved models under small-farm conditions. A continuation of the process is necessary to ensure an adequate supply of adapted technologies to further the development of Central America and to improve the living standards of subsistence farmers.

Traditionally, the area's national institutions have experienced ups and downs with regard to research, and in particular to livestock research. Changes in government policies, priorities, or resources have often started or halted the research process. CATIE, however, has provided an appropriate backbone for national research institutions in the form of continuing research and technological support. One way in which continuity has been assured is through the formation of a Latin American Livestock System Research Network that has been sponsored by IDRC since 1981. The network will fill a gap by coordinating livestock systems research activities and providing the appropriate means for an efficient exchange of information. General aspects of methodology are refined at the annual meetings of the network and common problems in component research are being addressed.

The process of exchanging information on new projects and sharing experiences should be assured among institutions involved in the same type of activity. Resources would be used more efficiently if national institutions knew who was doing what in some areas of Latin America, and financial savings could be obtained by avoiding duplication of research activities.

CHAPTER SIX



PRIMARY-SCHOOL TEACHERS IN EGYPT*

In 1982, a team of researchers from the Faculty of Education at Ain Shams University carried out a research project entitled *Status of Primary-School Teachers in Egypt*. The study involved 63 part-time researchers and cost CAD 93 000 of which IDRC contributed CAD 73 000. At that time, the government was prepared to embark upon a major program to retrain primary-school teachers. To implement this policy decision in the best possible way, however, the Ministry of Education needed much better information than it had about the 140 000 teachers in the country — their academic and teaching qualifications, their teaching skills, and their socioeconomic status. This chapter illustrates some of the difficulties met in public policy work: where are the "optimum" decisions about what to do and how to go about it? It also shows the role that descriptive research can play in the process of trying to improve decisions about and programs of investment in a nation's most important development resource: its children.

THE SETTING: EDUCATION IN EGYPT

Education is universally acclaimed as a prerequisite for development, or as a necessary condition for solving problems of underdevelopment. For more than a century, however, the educational system in Egypt has itself been a problem. Currently, there are some 7.5 million pupils and 140 000 teachers in the country. Although numbers of students and teachers have grown at all levels, especially primary (also called "compulsory," "elementary," and, of late, "basic"), the overall qualitative picture at this level has remained static or even deteriorated. Also, levels of remuneration, social status, and job satisfaction

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**This chapter was prepared from a study carried out by Dr Saad Eddin Ibrahim, Professor of Sociology, American University, Cairo, assisted by Dr El-Safty and Dr Amani Kandil.*

vary considerably among teachers in urban, rural, industrial, and desert communities.

The Arab Republic of Egypt has set itself an ambitious educational goal: universal primary education by the year 1990. The reasons for such a policy are basic: primary education is the level most available to the Egyptian people, it is considered to be their "right," and it is said to prepare every child both to achieve his or her own ambitions and to contribute to the development of the state. However, expanding the opportunity for education does not mean improving the quality of education. Quite the contrary, unfortunately, is the case in much of the world.

The primary-school teacher is considered to be the linchpin of educational reform — the decisive factor in achieving the individual and national goals of universal education. The Ministry of Education in Egypt has, over the years, gradually increased the certification necessary to become a primary-school teacher from 11 years of schooling in 1955, to 2 years of university in 1962 and to 4 years of university more recently. Only a small number of teachers have this level of qualification and against this background, the Government of Egypt has taken firm action to upgrade the education both of teacher trainees and of the 140 000 practicing teachers.

WHAT HAS HAPPENED: POLICY AND PROGRAM EVOLUTION

In September 1979, Egypt's Ministry of Education issued a working paper that noted the unsatisfactory state of education in the country, proposed tentative reforms, and called upon experts and opinion leaders to debate the issue.

Two years later, the People's Assembly — Egypt's parliament — passed Law 139, which the President ratified on 9 August 1981. The new law unified and integrated all regulations bearing on Egypt's entire educational system. It decreed, among other things, that the first, compulsory, stage of education was to be called Basic Education, and was to span 9 years. Its objectives were to establish closer links between education and employment and to improve the integration of schools with the local community and environment through diversification of curricula that allowed for acquisition of practical and relevant skills.

Also in 1981, in response to a general request by the Ministry of Education, the Faculty of Education at Ain Shams University proposed a research study to provide information on the teaching competencies and the socioeconomic status of primary-school teachers. With funding from IDRC, the research was carried out in 1982 under the direction of Dr Abdel Ghaffar, then Dean of the Faculty.

After the study was completed, the Minister of Education (then Dr Mustafa Kamal Helmy) asked a team led by Dr Abdel Ghaffar to translate its recommendations into a program of action. The new team consisted of most of the principal researchers who had taken part in the study, along with several professors from other faculties of education and a few from the National Centre for Educational Research (NCER). They met frequently over 60 days:

- To analyze the Canadian-sponsored study in depth;
- To establish the appropriate level to which primary-school teachers would be upgraded; and
- To plan the upgrading program in terms of courses; total number of credit-hours required to graduate; numbers of students to be enrolled every year and criteria for their selection; methods of instruction; reading materials; examinations; numbers of textbook authors, instructors, and administrators; and budget estimates.

The Ministry of Education approved, with minor modifications, the plan submitted by the team, including the proposal for a *Program for Upgrading Primary-School Teachers*. The Faculty of Education at Ain Shams University was entrusted with overseeing implementation, finances, and administration of the program. The academic aspect of the planned program was submitted to Egypt's Supreme Council of Universities, with the request that the Bachelor of Arts degree be granted to those who successfully completed its 4 years. The request was officially approved on 10 March 1983, thus clearing the way for concrete action.

Dr Abdel Ghaffar, who was put in charge of overall implementation, established a Supreme Supervisory Committee consisting of all 13 deans of Egypt's faculties of education to help in the task.

In July 1984, the Ministry of Education issued a white paper on *Developing and Modernizing Education in Egypt: Policies, Plans, and Programs of Implementation*.

Of immediate concern is what the white paper had to say about primary schooling. Two policy proposals stand out in this regard: first, the proposal to replace "Primary Education" with "Basic Education." This implies extending compulsory schooling from 6 to 9 years and diversifying the curriculum to include "practical subjects" designed to equip pupils with knowledge and skills enabling them to make a living or to continue their education. Second, it was proposed to train new teachers for Basic Education and to upgrade present primary-school teachers to college level for the same purpose.

On the last point, the white paper said that all who responded to the working paper of 1979 were unanimous on the need to accord the highest priority to preparing and training teachers and to enhancing their professional and socioeconomic status. Opinion was also nearly unanimous on the necessity for a university education for teachers at all levels — basic, general secondary, or technical secondary. "Some 140 000 primary-school teachers are to be upgraded to the university level."

THE PROGRAM

The *Program for Upgrading Primary-School Teachers* is, by all accounts, the first time that the Egyptian government has officially committed itself to enhancing the professional and socioeconomic status of teachers involved in the first stage of formal education.

It started in the academic year 1983/84 with 6000 student teachers in the Greater Cairo area. In 1984/85, it expanded to Alexandria, Dakhahlia, and Gharbia, where there are faculties of education to supervise it and provide lecturers. In its 2nd year, the program attracted 9000 additional students, bringing total enrollment to 15 000 in 1985.

According to the Minister of Education,[1] 18 000 more students will enter the program in 1985/86, and the geographic scope will expand to include four additional governorates. The plan is to keep expanding scope and enrollment until some 140 000 primary-school teachers with subcollege qualifications have all been upgraded. This is expected to be accomplished in 10 years, by 1993/94.

The program seeks to upgrade the primary-school teacher's efficiency and ability to participate in general activities and administrative matters, to develop academically and professionally, and to play an active role in developing education, raising the standard of the profession, and in community development.

Enrollment in the program is open to all primary-school teachers, but preference in selection is given to those who have been working for at least 10 years and who hold a diploma from the 5-year teachers' institutes following the preparatory school certificate (granted upon passing the ninth grade). Older teachers who have fewer than 14 years of service before retirement are discouraged from applying.

The program covers a period of 4 academic years, each comprising 30 weeks. The academic year is divided into two 4-month terms and a 2-month summer term.

In the first 2 years, the student takes general courses aimed at preparation for the first 4 years of basic education, in addition to courses in psychology and education that are meant to help him or her in the profession. In the last 2 years, the student must specialize in either Arabic language, religion, and social sciences or in science and mathematics.

Practical subjects are taught in all 4 academic years, and students are expected to choose one field — commerce, agriculture, industry, or home economics.

The terms are based on a credit-hour system, and the examinations held at the end of each term are mostly the multiple-choice type. A student who scores lower than 50% in any subject fails the course. However, a student can pass from one academic year to the next if no more than two subjects are failed, provided that he or she repeats the examinations in these subjects the following year. If any subject is failed at the end of the 2nd year, the student cannot progress to the 3rd, when specialization is required. All subjects that were previously failed must be passed before the student can go on to the 3rd year, and he or she cannot sit for reexamination in any subject more than once.

Professors are assigned to write special books for the program and, although these professors teach in the Faculty of Education in Ain

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[1] *From an interview with the Minister, Dr Abdel Ghaffar, conducted by Dr Saad Eddin Ibrahim (1 July 1985).*

Shams University, the texts are not the same as those used in the faculty.

Classes start at 5 P.M. — after official working hours — and students are not paid to attend. Professors are paid according to the number of hours they teach, and those who are assigned to write books receive additional remuneration.

The organization of the program and its implementation rest upon the concept of "remote education." In addition to attending lectures and meetings with their professors at the training centres, students enrolled in the program have the opportunity to listen to (or watch) lectures on national radio and television during designated hours every week.

THE RESEARCH PROCESS

OBJECTIVES

As mentioned earlier, the purpose of the *Status of Primary-School Teachers* study was "to determine the teaching competencies as well as the socioeconomic status of Egyptian primary-school teachers." It was conducted "within the framework of the country's serious attempts at the comprehensive development of all aspects of the educational process," and is one of several studies undertaken by the Faculty of Education on various aspects of Egypt's educational system.

Specific goals of the study were

- To develop a list of teaching competencies that enable teachers to perform their jobs effectively;
- To develop tools for teacher evaluation;
- To present a true picture of teachers' status;
- To describe a set of teaching skills to serve as a basis for retraining primary teachers and upgrading their proficiency; and
- To develop the foundations of competency-based, on-the-job teacher training.

RESEARCH DESIGN

The methodology consisted of eight interrelated steps. First, the literature on competency-based teacher education was reviewed, with a view to developing a list of teaching competencies that had proved relevant in previous studies. Second, whether Egyptian primary-school teachers actually possess such competencies was determined and, third, research tools were designed to measure them.

Fourth, a representative sample of primary-school teachers with different backgrounds was selected from all over the country. Fifth, a group of assistants was trained to use the research tools, to contact authorities in the Ministry of Education, and to select research sites that would facilitate field work. Sixth, data were collected through classroom observation and through questionnaires administered to teachers, supervisors, and school principals. Seventh, the data were analyzed and interpreted. Finally, eighth, policy recommendations geared toward competency-based teacher education were formulated.

OPERATIONALIZATION OF RESEARCH DESIGN

The team decided on four major research tools: the Teacher observation form, the Supervisors' questionnaire, the Principals' questionnaire, and the Teacher socioeconomic status inventory.

The Teacher observation form comprised 69 items bearing on six dimensions of teaching competency. A trained neutral observer was to attend one class and check the presence or absence of each item in the teacher's performance. Value judgments on the part of the observer were intended to be absent or minimal and only for a limited number of items did the observer have to write in a qualitative remark.

The Supervisors' questionnaire comprised some 49 items bearing on five dimensions of teaching competency. Although all were part of the Teacher observation form, the items in this questionnaire were to be filled in by the supervisors regarding their respective teachers in the sample and most items called for subjective evaluation of those teachers.

The Principals' questionnaire comprised 32 items bearing on six dimensions of teaching competency — some new and others overlapping with the two previous questionnaires. Most items to be filled in by school principals called for expression of opinions.

The Teacher socioeconomic status inventory comprised 31 items eliciting biographical data such as career, income, ownership of durable goods, and level of savings, as well as eliciting attitudinal and perceptual data on level of job satisfaction and self-assessment vis-à-vis the community and other occupations. This was the only questionnaire to be completed by the teacher.

Termed "Competency Sets" in the study report, nine dimensions of teacher performance in class, school, and community were observed (Table 1).

Table 1. Competency sets and their utilization in research forms.

	Research form		
Competency dimension	Teacher observation	Supervisor's questionnaire	Principal's questionnaire
Lesson planning and preparation	X	X	–
Achieving objectives	X	–	X
Teaching process	X	X	–
Use of subject matter, audio-visuals and learning activities	X	X	X
Interacting with pupils and classroom management	X	X	X
Evaluating pupils	X	X	–
Regularity in attendance	–	–	X
Establishing sound relationships with others	–	–	X
Preparing to solve community problems	–	–	X

THE SAMPLE

A sample of 1039 primary teachers was drawn from 72 schools in 6 of Egypt's 25 governorates — Cairo (the national capital), Daqahlīya and Ismailia (Lower Egypt), Asyūt and Sawhaj (Upper Egypt), and New Valley (Western Desert). General characteristics of the sample were: 48.3% males versus 51.7% females; 61.0% of the subjects were qualified teachers, i.e., with at least a diploma in education; and 51.7% were from urban areas, 18.5% from industrial areas, 17.9% from rural areas, and 11.9% from desert areas.

RESULTS

The data revealed that the overall teaching competency of Egyptian primary-school teachers ranged from weak to moderate.

The study considered the possession of less than 25% skills exercised in any of the nine competency sets as *very weak*; from 25–50% as *weak*; from 50–75% as *moderate*; and more than 75% as *good*. Accordingly

- Scores were lowest (very weak) on Use of subject matter, Audio-visual aids, and Activities. Even when the sample was broken down by governorates, area, sex, and qualification, rarely did any subcategory exceed the 25% mark.
- Other competency dimensions that featured weak scores were Teaching process, Evaluating pupils, and Achieving objectives, in that order.
- Teachers scored moderately (i.e., possessed 50–75% of relevant skills) on four of the nine competency sets — Preparing to solve community problems, Lesson planning and preparation, Interacting with pupils and classroom management, and Establishing sound relationships with others — in that order.
- On only one dimension of competency did teachers score highly (more than 75%): that was Regularity of attendance.

The greatest variation in scores on the above was displayed among the governorates. Teachers from Cairo scored lowest of all governorates on five of the nine competency indicators and never scored highest. In contrast to Cairo, those from Sawhaj Governorate scored the highest on four of the nine sets and were followed in overall performance by their counterparts in the New Valley and Asyūt governorates. Curiously, this rank order corresponds with distance from the capital (Sawhaj being the farthest).

Variations associated with area or environment were next in degree. Teachers in desert districts demonstrated the highest overall performance, and those in rural and industrial areas, the lowest. The scores of teachers in urban areas fell between the two extremes.

There were some variations associated with sex of teachers. Men performed better than women in six of the nine competency sets but female teachers did slightly better on two competency sets — Lesson planning and preparation (55 vs 53%) and Evaluating pupils (48 vs 47%).

The least variations observed were those related to teachers' qualifications. The study did not reveal any significant differences in scores between holders of a special diploma in education and those who had not received any teacher training.

Finally, we come to the results of the Socioeconomic status survey. The data were analyzed and presented only in terms of the environmental variable or type of community, i.e., urban, industrial, rural, and desert. The sharpest differences, real and perceived, on most indicators existed between urban and rural districts.

Urban teachers were 10 years older (averaging 39.3 years), with nearly twice the number of teaching years (11.2), better educated spouses (median of secondary-school certificate), and with fewer children (average 1.9 vs 3.0 in rural areas).

The contrast between teachers in the two types of communities extended to levels of income and savings. Those in urban areas had a monthly average income of EGP 94.8 compared with EGP 51.7 in rural areas (in 1982, 1 Egyptian pound [EGP] = 1.76 Canadian dollar [CAD]). The former saved about EGP 28/month, against EGP 14 for their rural counterparts. More teachers in urban districts than in rural districts possessed durable goods and other amenities.

When it came to perceptions of self, job, and status, however, primary teachers in desert areas scored positively higher than their counterparts in the other three communities. For example more of them felt good about their general appearance (84% compared with 52% in industrial areas), and expressed greater job satisfaction (92% compared with 73% in industrial areas). Likewise, more of them expressed satisfaction with their social status (74% compared with 55% in rural and 65% in urban areas) and economic status (57% compared with 32% in rural and 33% in industrial areas). On these indicators, teachers in urban areas scored next to their desert counterparts.

About 33% of all teachers would leave the profession because of social or economic reasons. However, the percentage was markedly lower for urban and desert teachers (22 and 26% respectively).

What emerges from the above is that, although urban teachers enjoyed the best socioeconomic conditions, they felt second-best about them. Teachers from desert areas were second in socioeconomic status yet were most satisfied of all groups with their status. Teachers from rural areas experienced the worst socioeconomic conditions — and they perceived them as such — so were the least satisfied.

RECOMMENDATIONS

The study concluded with three sets of policy recommendations related to improving the teaching–learning climate, upgrading teacher competencies, and developing teacher-preparation programs.

The first set is quite general and could apply to the overall educational system in Egypt — or, for that matter, any other part of the world. The second and third are more specific and, for the purposes of this report, more relevant.

Upgrading teacher competency would entail

- Upgrading the proficiency level of the supervisor and making his or her role more of an "advisor" than an "inspector";
- Making the evaluation of teachers' performance part of the tasks of both the senior teacher and the school principal;
- Changing seniority as the sole basis of promotion to more complex criteria in which academic qualifications and teaching competencies would have greater weight;
- Upgrading the training of principals to include administrative as well as professional competencies;
- Establishing teachers' centres in their local districts where continuous upgrading courses, workshops, and other innovative activities would take place;
- Raising the socioeconomic status of primary-school teachers to enhance their security and community standing;
- Consolidating and improving the system of evaluating pupils by teachers; and
- Impressing upon teachers the need to give equal emphasis to the affective, psychomotor, and cognitive aspects of the teaching–learning process.

The third set of recommendations calls primarily for confining primary-school teaching to holders of college degrees and special certificates of education and raising the level of present primary-school teachers to college level through special evening or correspondence courses or some other arrangement (e.g., open university). It is assumed that such courses, as well as teacher preparation programs in general, would improve teaching competency.

PRELIMINARY COMMENTS ON THE UPGRADING PROGRAM

The upgrading program has been in operation for 2 years and it will be another 2 before the first class graduates (at the time of writing, mid-1985). The impact of the program on the graduates' performance as teachers will not become apparent for many more years after that. Thus, a complete evaluation is premature at this point.

The detailed outlines for 60% of the courses in the upgrading program courses make them almost identical to those of the university's arts and science departments. Of some 65 courses taken in 4 years, 13 are in the field of education proper (i.e., preparation for the teaching profession). These education-related courses account for 47 of 300 credit-hours required in the program, or about 16% of the total. The vocational and community-related practical subjects constitute the equivalent of 32 credit-hours, or 11% of the total. Thus, all in all, the educational and practical subjects together make up roughly 25% of the program.

In the 4 years, the students are assigned some 80–90 textbooks, averaging 400 pages each, and 85% of the courses require written examinations. Given the limited time available to the typical student, who is a teacher from 8.00 A.M. to about 3.00 P.M. daily and may attend classes or listen to lectures on television from 5.00 P.M. to about 9.00 P.M., whatever energy that may remain goes to exam-oriented cognitive learning. The chance to develop other skills or innovative abilities is seriously restricted.

DROP-OUTS AND FAILURE RATES

The official records for the upgrading program in Cairo proper (not Greater Cairo, which includes Giza Governorate) indicate that, of about 4990 teachers who enrolled in the 1st year of the program (1983/84), 4270 sat for the end-of-semester exams. This means that about 720 students, or 14% dropped out in the 1st year. Some information is also available on failure rates. Of the 4270 students who sat for exams in the 1st year of the program, 2820 or 66% passed. Those who failed more than two courses, and hence had to repeat the 1st year, numbered 1450 or 34% of the total.

POLICYMAKERS' VIEWS

In 1985, Dr Ghaffar was Minister of Education and the legitimate "father" of the program. Five years before becoming a cabinet member, he had coauthored the working paper on Egypt's state of educational affairs, which triggered debates, discussions, and research. He was then Dean of the Faculty of Education at Ain Shams University, and worked closely with Dr M.K. Helmy, then Minister of Education. Again, Dr Ghaffar was instrumental in drafting Law 139 and the white paper on *Developing and Modernizing Egyptian Education*. Equally important, he directed the IDRC study of the status of primary-school teachers, and was first director of the upgrading program. Few men in Egypt's educational establishment have managed to play all these roles. Dr Ghaffar noted the following.

- Results of the program have generally exceeded earlier expectations.
- The study sponsored by IDRC was instrumental in planning the program; however, both the study and program are only part of wider research and policy efforts to overhaul Egypt's educational system.
- The upgrading program is more diversified than, and hence superior to, college-of-education curricula. The latter offer nothing, for example, on environmental, vocational, or religious education.
- There are some minor problems with finance and management — funds are lower than the program needs and management at the governorate and training centre levels is inexperienced.
- The academic side of the program is somewhat heavier and more difficult than it should be.
- On balance, the books used are authored by the best specialists, and the success rate of students is higher than in university faculties of education.

This generally positive assessment was shared by another high-ranking figure in the educational establishment, Dr Youssef Khalil, who until recently was Director of the NCER. He retired in 1983 and is currently a special advisor to the Minister of Education.

Other technocrats in the Ministry of Education and researchers at NCER have less positive views. Their criticisms centre on poor dissemination of the study carried out by Ain Shams University, the lack of involvement of NCER in planning the upgrading program, and the tendency for the management of the program to be monopolized by a particular "clique."

PROFESSORS' VIEWS

About 100 professors are engaged in teaching in the upgrading program in Greater Cairo and 10% of these were interviewed as a sample. They had comments on the implementation of the program (poor facilities at training centres and too much reading in proportion to teaching hours), their own financial and moral rewards (despite some problems, they would persevere), and their students (high rate of absence and lack of initiative).

The professors made the following suggestions for improving the program.

- Teaching hours should be increased and the amount of book reading decreased by 30%.
- The teaching load of those enrolled in the program should be halved so they can devote more time and energy to their studies.
- The students should have the summer off — teaching for 9 months of the year and studying year-round for the upgrading program leaves little time for rest.
- The selection criteria should be improved to admit only the more motivated and the best intellectually into the program.
- Physical facilities in the training centres should be improved.
- The television and radio educational programs directed at students in the upgrading program should be better prepared.
- The management of the program should be more decentralized.
- Greater diversity should be allowed in assigning and authoring textbooks — present practice is centrally determined with textbooks commissioned by Ain Shams University's Faculty of Education in collaboration with a supervisory committee made up of deans of other colleges of education.
- The number of practical and education courses should be doubled.
- A better system of evaluating the program, professors, and students must be devised.

The general impression from the interviews with the professors was favourable to the concept of the upgrading program. They were disappointed in many aspects of its implementation, but quite hopeful that some of the present defects would be corrected.

STUDENTS' VIEWS

About 7000 students are officially enrolled in the program in the Greater Cairo area. On the basis of interviews with 50 of them (0.7% sample) using a standardized form, the following perceptions about their attitudes emerged.

- Many thought teaching was an honorable profession — close to 65% expressed satisfaction with their careers, citing self-fulfillment and respectability as reasons; the remaining 35% said they were dissatisfied because of society's low esteem for teachers, the meagre financial rewards, and the hard work involved.
- About 25% thought very highly of the status of their occupation in society; however, slightly more than 30% ranked their occupation as low.
- About 65% came to the program mainly to raise their academic standard and about 20% reported the desire to get a university degree as a prime reason for being involved. Fewer students mentioned social status, promotion, and salary raises as considerations.
- More than 35% thought the material taught in the program was way above their heads, but close to 65% felt otherwise — a standard complaint was that too much was required and the number of class-hours was not sufficient to cover or digest the material assigned.
- Nearly 65% of students also complained about the scheduling of classes, but only 25% had difficulty getting to the centres where classes are held.
- Nearly 75% of the sample rated their professors as "good" — about 25% gave them an average rating. It is interesting to contrast the students' generally positive view of the credentials of their professors with the professors' generally negative view of the intellectual quality of their students.
- However, about 50% reported professors' irregularity in attending classes and a lack of responsiveness to their questions in class, and 40% said that their professors were generally not helpful at all.
- Most of the students felt the program had a positive impact on their academic standard but 20% were either unsure or felt that the program had made no difference — most of them also reported that their own teaching methods and performance had improved as a result of the program.
- Significantly, almost all students indicated their firm intention to complete the program, and would also recommend it to colleagues who have not yet enrolled.

CONCLUSION

Because of its potential impact on the largest part of Egypt's school population — some 7.5 million pupils and 140 000 teachers — the upgrading program is a landmark in the country's educational landscape. The speed with which the decision was made and implemented after such a long period of relative inactivity makes the case remarkable — and risky. Various forces — individual, political, social, academic, and bureaucratic — converged to produce the policy. No less significant was the interplay between action-oriented research and policy-making and between international development agencies and national institutions.

Confronted by mounting criticism of the state of primary schooling in Egypt, the Minister of Education in turn put pressure on the top bureaucrats to overhaul the system. Although somewhat averse to change and generally sceptical about academics, the ministry officials sought the advice of all the country's 13 deans of education, who were more than eager to be involved. Had their support not been solicited, the process of reform would probably have bogged down.

Of course, the search for solutions that began during the presidency of the late Anwar Sadat could have stalled at any point, but Mr Sadat's successor, Hosni Mubarak, was looking for fresh ideas and shared his wife's keen interest in educational reform.

In funding the research components of the process, prestigious international agencies such as IDRC and the World Bank added a rational dimension to the debate and imbued the whole effort with a "scholarly legitimacy."

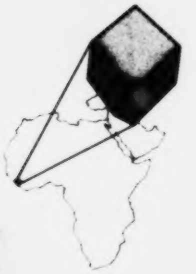
The upgrading program may have been hurriedly planned and implemented; however, those who were deeply committed to the concept may have felt that it was better to exploit the momentum and do the refining later. Consequently, several weaknesses were bound to appear and some of the views voiced by critics of the scheme may be quite valid professionally. It is hard to draw the line, however, between unbiased assessment and opinion that may have been motivated by bureaucratic and professional jealousies.

As an example of the role of research in the development process, the program has several deficiencies and some striking features. It does not address the most fundamental question that lies at the end of a chain of questions: assuming that the program is maintained and run efficiently, will it make primary-school teachers more effective? Will the children be "better educated" in the sense of being better prepared to lead more fulfilled lives and contribute more to society? Such questions clearly offer great challenges to the acts of faith upon which many public interventions are based.

One feature of this chapter is that it is unfinished. The process of deciding and acting, of evaluating actions and trying to adjust them, then deciding and acting again continues. Those who operate on the basis of fixed-term projects should never be so short-sighted or immodest as to presume that their interventions are the be-all and end-all. Also, no social system operates in a totally rational fashion so that problems are accurately perceived and research is perfectly done to produce cast-iron results, on the basis of which perfect decisions are made and ideal programs implemented. This chapter has not disguised the imperfections of the process. To give one example, the research study found that there seemed to be little difference between formally qualified and nonqualified teachers in terms of some aspects of teaching competence. Yet the upgrading program is focused more on providing teachers with formal qualifications than on improving their teaching abilities per se. Is the research finding true and, if so, is it a defect in the program that greater attention is not given to how to teach better? Obviously, there is further scope for research as those responsible seek the elusive optimum.

Finally, like many others, this example is very much to do with the drive and commitment of an individual — Dr Abdel Ghaffar. As is shown, he was present as a leading figure at each stage in the process — coauthor of the 1979 working paper on the state of education, head of the research team, head of the team asked to design the program, and Minister responsible for its implementation. An important point to make is that the program was committed before he became Minister and continues without him (he has since left the cabinet). Unquestionably, however, social development depends on such people — bureaucracies and processes are merely the contexts within which they strive.

CHAPTER SEVEN



RURAL SANITATION IN SIERRA LEONE*

In 1981, a small nongovernmental organization in Sierra Leone, called the Community Development Council (CDC), drew up plans to see whether a community approach for water and sanitation development was possible and whether it could improve the health of village people. With funding from IDRC (CAD 44 000), the project was carried out between 1982 and 1984. It involved three villages of about 55 households or 350 people each, simple designs for three wells and three latrines per village, and a community-based approach to health education. Professor R. Beaujot visited the area in 1985 as an independent observer and professional sceptic to assess whether the wells and latrines were really working, whether there was genuine community involvement, and whether peoples' lives have really been changed. This chapter illustrates the fundamental nature of some development needs and the importance of indigenous initiative and effort in meeting them. It tells of a particular kind of research — sometimes called "experimental development" — with, in this case, the prospective beneficiaries taking charge and conducting development research on their own lives. Finally, and most important, the chapter shows how the impetus came from and the momentum was maintained by an enterprising, dedicated individual, S. Kabbah, project leader and head of the CDC.

THE SETTING

Sierra Leone is a country in West Africa bounded by the Atlantic to the West, Guinea to the North and East, and Liberia to the South. Its population is estimated at 3.6 million, occupying an area of 72 325 km^2.

**This chapter was written by Roderic Beaujot, Associate Professor, Department of Sociology, University of Western Ontario, London, Ontario.*

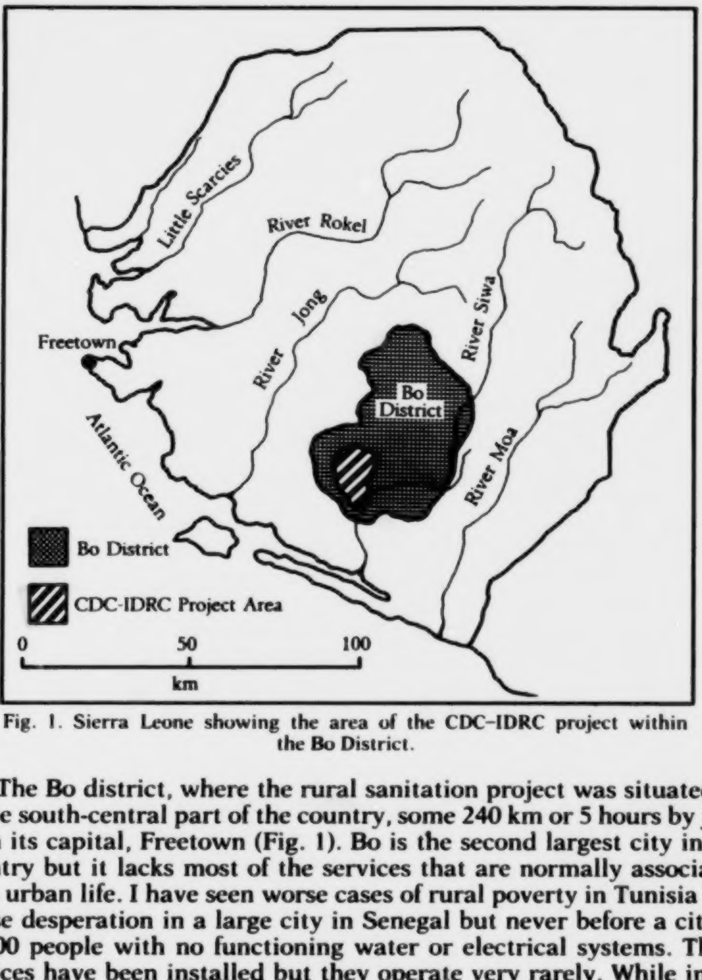


Fig. 1. Sierra Leone showing the area of the CDC–IDRC project within the Bo District.

The Bo district, where the rural sanitation project was situated, is in the south-central part of the country, some 240 km or 5 hours by jeep from its capital, Freetown (Fig. 1). Bo is the second largest city in the country but it lacks most of the services that are normally associated with urban life. I have seen worse cases of rural poverty in Tunisia and worse desperation in a large city in Senegal but never before a city of 50 000 people with no functioning water or electrical systems. These services have been installed but they operate very rarely. While in Bo for 6 nights, I did not once see myself in a mirror, never spotted a newspaper, and only once heard a radio.

The villages that are involved in the project are within 30 km of Bo. They are in the Tikonko Chiefdom, where the main economic activities are subsistence farming and mining, and the tribal language is Mende. Each chiefdom is headed by a paramount chief and each village has its own chief. The chief of a small village has considerable status, even though he may be a subsistence farmer, and it is essential for outsiders to work through these traditional authority structures.

The only means of access to about 40% of the villages in the chiefdom is by footpath through the jungle or by canoe across a river. These villages, which are situated "beyond the end of the road," were not considered for the project.

One way to describe the villages, even those that are on the road and thus part of the project, is that they are "in the bush." The natural landscape is a jungle, in fact the main problem with farming is stopping the bush from taking over the fields.

The three farming villages that were part of the project involved 60, 60, and 43 households, with an average household of about six persons. Thus, the number of persons affected totaled about 1000. One village is on both sides of a road, the other two are "at the end of the road," with one by a large river. The three villages had been chosen, after consulting with the Paramount Chief, because they differed somewhat among themselves, and because it was felt that the villagers would be interested, or at least that they would not be averse to allowing anyone in.

It was the health aspect of life that was mostly to be influenced by the project. The United Nations places the population's average life expectancy at 34 years, one of the lowest in the world. Although the infant mortality rate is about 200 deaths per 1000 births, there were no obvious signs of malnutrition. Medical facilities are in short supply, even in the cities, but questions of water and sanitation are apparently particularly relevant to the health of villagers.

In a village that is to be part of the second phase of the project, I observed two women taking water from a place in the stream where it was available during the dry season. The stream was not running. There was a type of fence around the water hole to prevent animals from using it, but the fence was not in good condition. The water did not look good at all. The women took water to wash their clothes, later they used the same pails to bring water home for washing and drinking. It is possible that people came to wash themselves in the same water hole that was being used to draw drinking water: this was observed in another location. In general, it was not hard to document that the water was of poor quality and the villagers themselves thought this. In fact, as soon as the rainy season starts, they use water collected from the roofs for drinking. However, there was a myth in the village that water from that stream was good for fertility, and it would be hard to disprove this myth as the water had been used for generations and people in fact had many children.

One of the project villages is near a large river that runs within 70 m of some of the houses. Although it is very convenient to use, especially for washing, there are blackflies living near the water that cause river blindness (onchocerciasis). It was very hard for the Community Development Council (CDC) to convince the villagers of the danger of washing clothes or themselves in the river but the stones that had been used for washing clothes were no longer by the river bed. This would indicate that the river is no longer in use even though it requires considerably more effort to draw water from the well.

WHAT HAPPENED

Parts of what happened are easy to describe: wells and latrines were constructed. Other parts, involving health benefits, consciousness of health, or even community pride at having solved a problem, are much harder to document. This section starts with a description of the constructed wells and latrines, then tries to document other changes in the villages.

WELLS, LATRINES, AND HEALTH EDUCATION

Three wells and three latrines were constructed in each village between December 1982 and June 1983. The basic idea for the latrines comes from a World Bank description of a "Zimbabwean design for pit latrines" that a program officer of IDRC had sent to the project leader. These latrines, with a spiral entrance, have various advantages: there is no door that might fall off or be used for firewood; the ventilation is excellent, bringing air from outside down through the hole and back up through the vent that is outside; the flies tend to follow the same route and get caught in the screen at the top of the vent; and it is dark inside, thus decreasing the chances that flies will reproduce there. Of course, the latrine also accomplishes the basic purpose of getting the excreta under the ground. The changes that were made in adopting this design involved greater use of local materials.

Although it is dark in the project latrines, there is a certain wetness about the hole. I am told that, in the Muslim practice, the men wash after using the latrine. The wetness is a problem because it can attract flies and hold dirt. The use of paper as an alternative is not feasible due to the same religious practices. The CDC is considering building an adjoining structure so that personal hygiene washing could occur there instead of in the latrine. In fact, the project leader has built one of these latrine-shower units next to his house — although the "shower" here means that you take a pail of water in with you to wash.

Designed by the project leader, the wells were not based on a previous model. Because I am not at all an expert on wells, I cannot judge the extent to which this one is an innovation. On the other hand, I have seen other wells in Sierra Leone and I have no doubt that this is a suitable design for these villagers. Its basic advantages are as follows: there is an outside culvert that prevents cave-in; the top is completely cemented over except for a hole about 15 cm in diameter, that is the top of an inner cylinder through which the "bailer" passes down to the water. It is of course very easy to cover this hole when the well is not in use. The bailer, which is pulled by a rope, is designed in such a way as to take water from the bottom and to close through suction when it is being lifted. Should the rope break, the bailer can be retrieved with a hook because it cannot leave the inner cylinder. The bailer cannot possibly be used for other purposes, such as a container for washing clothes, and it is easy to keep the well covered and the bailer clean.

It is more difficult to piece together a description of the health education process. In each village, a local chapter of CDC was formed consisting of about six social, civic, and religious leaders or elders of both sexes from the community. Two members from each village committee attended a 1-month training course in basic health education. One criticism that might be expressed at this point is that the local committees included fewer women than men, even though many of the health questions related more directly to women (water, child care, and washing). The education of the villagers started with the construction of wells and latrines and lasted for 9 months after construction. Various audiovisual devices were used.

DIRECT OBSERVATIONS

What happened is partly described by comparing two villages, one being part of the project and the other — a "control" — being introduced in the second phase, just beginning at the time of the field visit. Both are on a road and have exactly the same number of households; each has a school, although one of the schools serves a broader district; both involve subsistence agriculture as essentially the only economic activity; both are Mende, the largest language group in the country; and both traditionally obtained their water from a stream, when it was running, and from holes in this stream when it was not. The main difference is that one is 14 km and the other 29 km from Bo, in fact further down the same road.

All the facilities (wells and latrines) in the project village visited were in use and in working order, except that the concrete wellhead had broken on one of the wells. This had happened because a low cement content had been used to reduce costs. The problem was not serious because the base was still intact. In fact, water was still being drawn through the inner cylinder, which was itself kept closed. Although the costs could not have been more than two or three bags of cement, the wellhead was to be recovered only when the second-phase funds arrived. (Cement is expensive and has to be purchased in Freetown and transported the 240 km to Bo by the purchaser.)

After we finished the interviewing in the two villages, my interpreter and I took a 20-minute "random walk" through these villages. This was the busy season for farmers, also a time of rapid plant growth, and we noted in both cases that some areas behind the houses were not well "brushed," although the areas in front of the houses were clean. We asked to drink water three times in each village. The water appeared clean, tasted good, and was kept in a clean area and covered. In the control village, this was rain water, which would not have been available in the dry season. Some wells in this village were open, others closed: in the project village, they were all closed. There were no containers for garbage — it lay behind the houses, but further away in the project village. There were few smells or flies, but fewer in the project village. The latrines in the control village were in poor shape — they lacked a roof, were smelly, and had some flies — and there was visible defecation behind some houses: such was not observed in the project village.

Clothes on the ground can be a source of disease, and in the control village, some clothes were on the ground, but others were on the lines: we did not see clothes drying on the ground during our stay in the project village.

A few additional observations should be made regarding the second project village that was visited. The last 18 km of road leading to this village were so bad that the cement used for construction had to be carried by the men over their heads for the distance. All the wells and latrines were in order except that a rope had broken on one of the wells. Because the well was not in use (a working one was very close), there were ants under the wooden lid covering the cylinder. This village was particularly clean: no visible garbage or excreta in front of the houses, clothes were on lines and not on the ground, and hedges had been planted in some localities. This was the neatest of the five villages that I visited.

Another observation that is worth making about this village concerns the interaction of the CDC leader with the chief. The discussion had to be translated because the chief was Mende and the leader was not. What was especially noteworthy was the way the CDC leader commended the villagers for their contributions and efforts. On other occasions, I noted how the leader was taking the opinions of villagers seriously. Although some locations for wells are not appropriate from a scientific point of view, he let them choose among the appropriate areas rather than imposing his own views excessively.

THE "BEFORE" AND "AFTER" SURVEYS

Survey questionnaires were completed in each village at the beginning and end of the project. The first round was completed in the period March–May 1983, and the second round some 8 months later. There were various problems associated with this research. For example, it is not always appropriate to ask heads of households (mostly men) about practices that mostly involve women (washing, care of children, food preparation, and water storage) and the answers to some questions could only be recorded in ranges instead of exact numbers — yet the difference between zero and two deaths in a household is rather large! There were also problems in the presentation of results in the preliminary and final reports of the project. Most of the percentages calculated were not very useful. However, a member of the IDRC staff said that the purpose of conducting the pre- and postproject surveys was not the data themselves, but to make sure that the CDC had talked to the villagers before the project was launched to get a feeling for the conditions and had returned later for follow-through. Now, there is a person who knows how to put survey research in an appropriate context! In that light, the following comments from the preliminary and final reports make interesting reading.

> It is indicated that 44.8% of the respondents usually see more than four flies on entry, while 36.2% see more than four cockroaches on entry and 19% see over four rats on entry. These findings reveal that the majority of the latrines in the sample villages are not in good condition. [Preliminary report]
>
> The core objective of the project was to break the chain of transmission of human excreta- and water-related diseases through preventive measures ... within selected sample villages. [Final report]
>
> Apart from pest infestations, latrine odour and other traditionally perceived discomforts associated with the use of pit latrines,

> some concern is usually expressed about the safety of the structures themselves. Such concern could range from fear that the latrine might collapse with a member of the community, or that the size of the hole might be too large, especially for children, to various sanitation concerns and taboos of the extended family structure. [Final report]
>
> Apart from providing adequate water supply, the constructed wells have other qualities which motivated sample households. For instance, during the dry season, members of households, especially women, usually had to walk long distances to collect polluted water from sources which are often disease-related, due to contamination by animals, human wastes, or dirty feet. [Final report]
>
> The general quality of wells and the changes in traditional attitudes towards maintenance and use of the facilities imply that sample households had wanted to have access to adequate sources of water supply, but had lacked the technical know how and required funds to achieve their goals for better health conditions. [Final report]

In spite of criticism leveled against the survey research, questions of behaviour and attitude at the household level can be reconstructed to compare the "before" and "after" situation. Much of this is done in the final report, although the appropriate tables are not presented. Table 1 has been taken from some 40 tables in the reports. These data indicate rather striking changes over a 9-month period: the habits of general cleanliness, including food storage and care of garbage, have improved; house pests have decreased radically; latrines are judged to be in better shape and especially cleaner; a switch has occurred from using the traditional stream or pond water to using well water (especially for drinking and cooking); and most judge the well water to be of considerably higher quality with regard to odour, turbidity, and larvae content. Not a single case among the 20 indicators presented would show a deterioration of conditions.

Table 1. Summary data (percentages)[a] on general cleanliness, latrines, and water from the before and after surveys.

	Before	After
General cleanliness		
Store food in covered containers or eat it immediately	88	100
Wash dirty utensils immediately after meals	20	48
Dispose of garbage properly (burning or pit)	17	25
Empty garbage container regularly and more often than weekly	23	57
Cover garbage containers	2	10
Dispose of garbage more than 12 m from house	13	62
Without house pests		
- mosquitoes	7	77
- bedbugs	10	79
- cockroaches	7	82
- rats	12	81
- flies	23	88
- fleas	37	93

(continued)

Table 1 concluded.

	Before	After
Latrines		
Latrines used for toilet (rather than bush or stream)	87	100
Latrine holes covered	42	70
Latrine floors with no trace of feces or urine	43	87
Latrines judged to be in good or excellent condition	27	52
Water		
Take water from well or pump (rather than stream or spring)	23	98
Use following water sources for drinking and cooking		
In rainy season		
- well	0	96
- stream or pond	66	3
- roof water	33	0
In dry season		
- well	24	85
- stream or pond	76	15
Use following source of water for ablution		
In rainy season		
- well	0	83
- stream or pond	69	17
- roof water	31	0
In dry season		
- well	28	43
- stream or pond	72	57
State odour in water supply as		
- none	27	93
- slight	47	5
- heavy	27	2
Note turbidity of water supply as		
- clean	33	100
- milky	32	0
- muddy	35	0
Use retrieving water container for		
- no other purpose	23	100
- laundry	13	0
- house cleaning	30	0
- storage	20	0
Stored water that is well covered	55	83
See less than two larvae in water storage	50	100
Judge source of water supply as good or excellent	28	100

Source: Preliminary and Final Reports for the before and after results respectively.

[a] Sample size: 60 households for each of before and after surveys.

INTERVIEWS WITH VILLAGERS

Besides getting documentation from CDC personnel and making direct observations in the villages, an important part of the field trip consisted of semistructured interviews with a sample of villagers. As a way of gaining access to the project and control villages, I insisted that I was a farmer's son and wished to visit a farm. I can ask good questions about farming and my interest is obvious, even when speaking through interpreters. This was helpful in establishing some common element of identity across such different cultures.

The villagers from the project village were quite interested in receiving a guest from IDRC. Those from the control village were a little reluctant at first and wondered about the confidentiality of responses. However, the ground had been prepared here too, because they were to be involved in the second phase and had already dug the hole for one of the wells.

A complete listing of households in each village was obtained and, from this, a random sample of 10 individuals was chosen. The sampling procedure ensured the inclusion of younger and older adults, as well as men and women. In addition to these 10, another 4 interviews were sought with persons from the village branch of the CDC. Someone from the village then warned each selected person that we would arrive the next day. Some of the respondents were not available at the appointed times and substitutions were made. Toward the end of the interviewing in each village, however, the able-bodied men and women who needed to be on their farms had stopped waiting for us. Instead of attempting further substitutions, fewer interviews were conducted.

The interview itself was open-ended to allow respondents to indicate their conceptualization of diseases and their causes.

Twelve interviews were completed in the project village and ten in the control village, where my translator and I had arrived 1 hour late. Selected transcripts from the interviews are presented at the end of this section.

In pursuing questions of diseases and their causes, most of those interviewed could identify elements in their environment that they thought were relevant. In both villages, a number of children had recently been sick and some had died, from what seems to have been smallpox or measles. This was attributed by all to the fact that the rainy season was unusually late this year. Only three respondents in the project village and one in the control village did not spontaneously mention things like impure water or exposed excrement as causes of disease. When asked what made them think that impure water or garbage (including defecation) could cause disease, most mentioned impurities in the water and commented that flies could go from the garbage to the food. Asked if they had thought for some time that impure water and garbage were problems, most said they had learned this through observations made in the course of their lives: very few mentioned the "health education" as the source of this knowledge. When questioned further about causes of disease besides impure water and garbage, a few from the project village mentioned the problem of drying clothes on the ground: this was mentioned less frequently in the control village.

We then asked, in the project village, how this water and sanitation scheme was important "for you." Most referred especially to the clean water from the wells. Asked why this project had succeeded whereas others — including a well built earlier — had been less successful, some mentioned the techniques of construction, others mentioned the interpersonal abilities of the project leader. In elaborating on the latter, some said that he had created a certain "oneness in the village." They said there was disagreement about the project at first and the men, especially, were not willing to offer their labour. At one point, the Chief had to levy a small fine on the workers for failing to do the work. An old man said that the women were more convinced of the value of the wells and that they were "beating up their husbands" to get them to do this work. Now that the project was completed, everyone was happy that they had contributed to its success. When we asked if there were any other reasons for its success, very few specifically mentioned the health-education component.

In the control village, we asked what they expected of the project. Again, clean water was mentioned most often. Asked what made them think that this project would be successful, most said that they had seen or heard of the wells in the project village 14 km up the road. Asked if there were any other reasons, none specifically mentioned that they expected to gain from the health education. We determined that there had also been difficulties here in getting the men to dig the hole for one well. Again, the Chief had to levy a small fine; he also gathered a small amount of money from each household to pay the workers. Further work depended on second-phase funds.

In general, these interviews document a relatively high level of consciousness regarding factors in the environment that affect health. The value of the control village as a point of observation is especially evident in documenting the diffusion of information to other villages from the project village. Although there were difficulties eliciting people's interest at first, especially because similar projects had failed in these very villages, we found considerable enthusiasm for the project. There is now almost universal interest in the second-phase village, but it does not match the overwhelming enthusiasm that was manifested in the project village.

Excerpts from Interview Transcripts in the Project Village

Middle-aged women's leader

Why did other wells fail? Because of the method used in their construction and people lacked training in the use of the facilities. Mr Kabbah trained them, taught them how to use the facilities. He explained to them how his method of making wells was good. After he had convinced them, they contributed to it.

What has changed as a result of the project? Before we were using the same water for toileting, washing, bathing, and drinking. Even when visitors came, they had to use the bush for defecation. Now we are living in good conditions. There is no need to go at night to get water. We can receive visitors better. Before the health overseers of the Ministry of Health levied fines against us because our facilities were not clean. We are no longer disturbed by these people .... Mr Kabbah is our son. He has made an effort to bring things to us, now we praise him to others.

Older woman, mother of six

Why do some children live and others die? Once God has given you a child, if it is not yours it will die. *Yes, are there any other reasons?* Sickness. *What causes sickness?* Fevers. *What causes fevers?* Fevers. *Are there any diseases brought by poor water?* Yes, malaria, diarrhea, typhoid, and smallpox.

How does poor water bring sickness? Leaves fall in the water and these particles make it polluted, also there are animals in the water. Good water cannot make you sick.

Young man, father of four

Why do some children die? Because of malnutrition, lack of health facilities, poor water, and lack of toilets. *How is poor water a problem?* When it is not flowing, and also used for toileting, water can bring diarrhea and dysentry. People had told us this when we were young.

Why were earlier wells not successful? They were not properly dug, not covered, not much attention was paid to them. *What helped this project to succeed?* The cooperation between Mr Kabbah and the town. This cooperation happened because Mr Kabbah was vigilant and encouraging. He even created a certain "oneness" in the village wherein chiefs and subordinates cooperated. He was able to do that because he has a human understanding.

Man aged 21

Why do certain children die? Some women do not take good care of the children, they do not take them to a hospital when they are sick. *What causes sickness?* Flies going from the excrement to the food can cause sickness because they bring diseases to the food. *How do you know this?* People come to tell us this.

Is there anything specific that you learned from this project? Before I used to use the bush, now I go to the toilet. I have been advised not to defecate in the bush because of the flies. *Why was this project successful?* Mr Kabbah knew how to dig wells. He created unity. We saw that he was bringing something good and we put our hands together to help him.

Women's leader, six young children

What are some causes of diseases? Mosquitoes and flies can spread diseases, especially if they come from garbage or excrement. People came to tell us this since I was a young adult.

Young woman, two children

Why do some children die? They do not receive the proper care. *Could it be that they get diseases?* No, sickness is sent by God. *Would there be other causes of sickness?* I am young, I cannot tell much. In general, I know that you can get sick from the ground or from water. People from the project told us about poor water bringing sickness.

Man of 35, one child

How did you come to know that poor water causes diseases? I have known for some time that when the water is not flowing in the dry season there are worms, flies, and mosquitoes in it that can bring diseases like malaria, diarrhea, and typhoid.

What did you learn through the health education part of the project? That the garbage should be kept far from the houses and that clothes should be on ropes so as to prevent diseases that are carried through the ground.

Why was the project more successful than others in the village? Other projects did not get the people involved. Mr Kabbah used the people in the village to get their advice. This created unity. *How did he do it?* He gathered people, discussed it, and found out who was interested. He did not lecture to us but got us involved.

Young mother, three children

How can improper toileting cause diseases? The flies can go to the food; when the odour is inhaled from unclean toilets it can create sickness. I learned this in school. Also, people from the town came to teach us about sanitary affairs.

Older man, three children

What are the benefits of the project? We have been told to clean the surroundings and to take care of the garbage. We pay more attention to this now. *Why was this project more successful than others?* They called on all the villagers including the chief, the local societies, and the women. The women forced the men to take the work seriously. They were coming to blows with their husbands to get them to do the work.

Excerpts from Interview Transcripts in the Control Village

Young woman, two children

What causes diseases to start? Food that is eaten, flies going from the garbage to the food, and possibly the water. The well at the back of our house is not covered, it is easily contaminated, one can see the sediment at the bottom. We do not know if it is contaminated. I learned this through experience.

What do you expect from the project? If it succeeds in the wells and latrines, I hope it will create a lot of goodness, less diseases, and less deaths. I expect the wells to be better because they will be covered.

Young man, two children

Why do certain children die? Sicknesses and diseases. *What are the causes of these?* Most important is from the water, also use of bush for toileting and improper garbage disposal. *How do you know this?* I was not told by anyone. I see that when there is excrement, people step on it, flies go to the food. *What about the water?* It is good in the rainy season but in the dry season it does not flow. It is not covered. It is turbid and there are also organisms in the water. *Anything else?* Domestic animals should not be in the village or in the houses. There is excrement near the door, people step on it, there are flies. Laundry should not be spread on the soil. A month or two ago my wife spread the laundry on the ground, it rained, there was something in a shirt that later bit my daughter, she had to go to the hospital and it took a month to get cured.

Single man in early 30s

Why do some children die? God is responsible. *Anything else?* Sickness. *What are the causes of sickness?* Dirtiness, mosquitoes, flies going to the food, and hard work. *What about water?* Yes, a lot of things go into it, flies, birds defecate from the air above, monkeys drink there, and we do laundry in it. *How did you learn this?* It is in our tradition; I learned it by myself. *Why do you expect the project wells to be better?* They are more solidly built, and covered.

Older woman, not healthy
Why do some children die? God is responsible, he is the creator. *Any other reasons?* God is responsible. Even if you're sick, God is responsible. *Can impure water or excrement be a problem bringing diseases?* I cannot tell .... Drinking impure water can cause disease. In this town, the water is creating problems. *What about garbage and excrement?* I don't have any idea .... It depends on God.

Older woman, 19 children
What causes sickness? Water can be a problem, mosquitoes, and scarcity of food. Water can bring diarrhea if it is not clean. Flies going from defecation to food is a problem.

What do you expect from the project? I have only heard a rumour about it. I was not invited to this. I was asked to pay 2 Leone (CAD 0.50) to pay for the meals of those digging the wells, but they did not explain why.

Middle-aged man, 11 children
What are some causes of sickness? As we sit here, the water that we drink is not good; in the dry season, we get impure water. When the rain comes, the water goes into holes, everyone touches it, that brings diseases and sickness. There are small organisms in it, we cannot purify it. Sickness can also come from food, or from garbage and defecation (flies and odour).

What do you expect from the project? It is especially a good well, as we have seen in the village down the road. Your people tested the well, and it is covered.

Middle-aged teacher, 15 children
Why do people die? There are various causes, lack of medical facilities, poverty, malnutrition, improper care of children, inappropriate medication, reluctance or inability to visit medical centre, and poor water especially in the dry season (not covered). We teach this in school.

Middle-aged male teacher
How did the community become interested in the project? It was very difficult to convince them to do the difficult labour. The chief used his authority, even levied fines and collected some money to feed the workers. Eventually people became convinced to do it. They knew that it was good but a financial incentive was necessary to get them to do the work.

Is there health education already? A team of nurses came last year, they emphasized the causes of sickness, for instance, drying clothes on the ground. They gave examples of how to live.

Older woman's leader, one surviving child
What are some causes of sickness? Water and the food we eat. Our well is not covered, things can go into it at night, we do not know what goes in. In the dry season, there is little water, we take it out with mud and let it settle. *What about garbage and defecation?* I do not know, we will have to look into that.

Older man, two children

What do you expect from the project? We will be happy to get the facilities, we are really suffering now; it will make a big change, especially the covered well.

PROJECT IMPACT

The health consciousness of the villagers has clearly been affected by the project. The wells and latrines are working well and are being used. We noted greater cleanliness in the project villages, and somewhat more consciousness of factors affecting health such as drying clothes on the ground. The interviews would suggest that it was especially the "selling" of the project by the CDC and the community involvement in the construction that encouraged this increased consciousness of health. The interviews would not permit us to conclude that the "health education" itself made a significant contribution to this increased consciousness. The following quote from the final report indicates that the CDC was aware of this complexity.

> Before their collective willingness by the local people, there had been long years of health education dialogue between the CDC and the people, and much voluntary teaching on rural sanitation and general community development also took place in the court barries and school rooms as well as in open spaces during the dry season.

On the other hand, education often comes in bits and pieces. It is very hard to identify the origins of a given item of knowledge.

With regard to enhancement of social or communal well-being as a result of the project, the mention of "oneness in the community" is significant. The enthusiasm evident in the celebration of the official opening of the project, at which a member of IDRC's head office was present, is another indication. One of the speeches made on this occasion was by a school principal from a neighbouring chiefdom. He clearly indicated that he wanted to see the project expand into his region and expressed eloquently the advantages of small projects over large ones. The pride in having other communities follow one's example must be important to the villagers' sense of self-esteem. Also, one senses that the villagers are proud to have started to gain some control over those health aspects of their lives that are affected by the environment.

The institutional impact is important. It would appear the small, self-help oriented nongovernmental organization (NGO) would hardly have been viable without the first-phase funding. The second-phase funding, however, may not have been essential to its viability as other granting agencies had expressed interest. In any event, the CDC did not wish to be absorbed by other funding agents and wished to remain loyal to IDRC. Besides growth and viability, another impact of the project on the NGO is that of increasing considerably its ability to perfect a product and assess its own achievements. As will be argued further, the fact that it was IDRC and not some other agent that provided the funds was probably crucial with regard to this specific research impact.

Another potential impact at the institutional level is the possibility that small NGOs like the CDC will come to play a larger role in development, especially in areas that are somewhat beyond government contact. Funding agents might do well to put more of their "eggs" in the hands of NGOs that have a certain track record and that are involved with people at the grass-roots level, who are often beyond the reach of the "formal sector."

In some places in Sierra Leone, in fact in villages near those I visited, they mine for jewels and, when they find one, it is a cause for celebration. Possibly I found a jewel in the bush: a very simple thing involving wells and latrines with the people in charge. The project is vulnerable, however. Other institutions may feel threatened because this project is accomplishing something that they were supposed to be doing — helping the people to improve their own lives. Indeed, some have already tried to undermine it, but the CDC got the wells constructed before anyone took note, and opponents could hardly close a good existing well. This little project may need protection.

Stated differently, there is a danger that the NGO could come into conflict with other institutions that may feel it is intruding on their "turf." One "division of turf" that seems to be worth pursuing is to convince these other agencies that an NGO with research objectives is not a threat. The same may be true of an NGO with self-help objectives.

HISTORY OF THE PROJECT

To get a sense of why this particular research and development (R&D) process started, it is useful to give some details of the history of the project. Probably the best place to start is with the project leader's involvement as a staff member of the National Training Centre for Rural Development (NTC) in Bo. S. Kabbah had specifically moved to this Centre from Freetown, where he was born and educated, to become involved in community development "out in the provinces." The NTC has a full-time staff of about six, plus part-time staff. They focus on questions of public health, community development, and sociology. There are about 35 students per cohort, and they spend 18 months in the program. An important part of the students' training is actual field work. Thus, staff members are always looking for good field placements for their students, and for projects that will contribute to community development. The Centre has very little funding and, as I understand it, students typically are sent to live and work in a particular village and to try to initiate some project. About all that the Centre can provide for them is their monthly rice ration, and even that often arrives late. Thus, the students must work for the villagers to get their food and lodging. Typically, they help with farm work, which allows them to get to know the villagers and gain their confidence. The villagers of course have to accept this arrangement, and that is not always easy.

Because he was a staff member of the NTC, the project leader had students to place for their field work: he is also somewhat of a specialist in questions of water supply and water quality. He went on his motor scooter to some villages of the Bo district and found that they too were interested in such questions. Specific villages were chosen as field placements for some of his students and he formed a unit that he called, at first, the Lembema Community Development Council, named after the village 14 km from Bo where the work was initiated. He got the villagers interested in building wells and latrines but had no money to buy the necessary materials. One well was constructed in Lembema with the help of funds from the Department of Social Welfare and Rural Development: this is now called the NTC well. The design was poor, however; the well is not covered and is no longer in use.

In March 1980, he formed the Community Development Council based in Bo with the idea that this unit would be able to secure funds. It was a very loosely knit organization including the leader's father-in-law and brother and a health educator employed by the Division of Public Health of the Ministry of Health. The project leader specifically chose people who had motivations similar to his own: people interested in a grass-roots approach so that the villagers can solve their own problems. He specifically did not want anyone who might sabotage the operation by acting in favour of their own financial interests.

Among the various attempts he made to secure funds was a letter sent to "The Director, IDRC, Ottawa, Canada" dated 16 April 1981. In this, on the third page, he asked for "$6,000 to be used for the purchase of cement, iron rods, corrugated iron, zinc nails and some building and constructional materials."

One would have thought that IDRC would simply have sent a polite "not interested in technical assistance" reply. An interview with the person who responded to the letter indicates otherwise: he was rather impressed that someone "from the bush" would be able to find IDRC's address and write such a letter. Consequently, a reply was sent indicating that IDRC might be interested if there were a research component, and that a representative from the Dakar office would try to visit when he was next in Sierra Leone. In response, the leader wrote a second version of the proposal (19 June 1981), which he called "a proposal for research on the improvement of water and sanitation facilities." He requested CAD 120 000 for the "first phase" of a "study project" to construct 50 wells and 50 latrines in 10 villages. Internal IDRC documents indicate that this "first phase" was considered to be much too ambitious for a newly formed NGO, and involved too much technical assistance and not enough research. The official IDRC response (14 July 1981) suggested choosing one or two villages to see if the CDC was capable of carrying out a modest project.

At about this same time, two IDRC staff members were visiting another project in Sierra Leone, and they found time to search for the CDC. The leader in Bo was obviously rather astonished to see them — "You came from Canada to see me?" — and they chatted with him for 3 hours. He made two more proposals, the last of which was dated February 1982.

In the meantime, the IDRC representative in Dakar made a second visit, which he describes in a trip report dated February 1982 — the telegram he had sent 9 days earlier had not arrived, there were no lights at the hotel, and some of the field visits were made on the back of the leader's small motorcycle. He also describes the poor sanitary conditions in the villages and the interest of the villagers in overcoming these problems. Finally, the IDRC representative pushed hard to include a social scientist on the team to conduct proper surveys. The same Dakar representative made a third visit in September 1982 and noted some difficulty in getting proper governmental approval. His fourth visit of August 1983 was made to coincide with the official opening ceremonies.

Other historical details are useful to recall. The project was approved in Ottawa in July 1982, the funds arrived in Bo in February 1983, and the jeep on 16 August 1983 — a day well remembered by CDC. The construction of wells and latrines took place between December 1982 and June 1983. The preliminary report covering the first round of surveys is dated September 1983 and the final report is dated June 1984.

BUDGET

The project cost IDRC CAD 44 000 in direct funding. Of the direct funding, CAD 35 000 was administered locally. These expenditures covered materials (cement, iron rods, etc.), transport and maintenance of the vehicle, per-diem allowances for staff while in the field, payment under contract for specific jobs (interviewing, a social scientist to carry out the surveys and interpret results, typist, clerk, and skilled labour associated with construction). Other than the per-diem and travel allowances, the CDC staff would not appear to have received any financial benefit. They are employed full-time in other capacities, and one is retired from the labour force. The CAD 8000 funding administered in Ottawa was used mostly to buy a typewriter, a duplicating machine, and a jeep.

DEFINITION OF THE PROJECT

In attempting to further comprehend why this particular R&D process occurred, it is useful to confront the varying definitions of the project that were obtained from CDC and IDRC.

In interviews with the project leader and with two other key members of CDC (the leader's brother and father-in-law), I asked them to define the project in their terms. The answer that could be pieced together from responses would go as follows.

> The idea was first to do something to help people improve their own lives in some villages of the Bo district. We thought that a project to provide wells and latrines in certain areas where they were greatly needed would be worthwhile. We had gone around some villages on a fact-finding campaign and determined that there was a great need for water and sanitation facilities as well as for health education. We were convinced that with a little advice and technical help to get things started, the people from the villages could mostly do it themselves. We also knew that it was not easy: for generations, the population has obtained its water from the streams and has defecated in the bush. It is difficult to change patterns of

> behaviour that are enmeshed in a whole way of living. We had seen many projects fail, mostly because those who try to help do not know the local conditions or because institutions do not work well here. Yet it should not be impossible to get water and sanitation into the villages. We felt this was a challenge.

At one point, before IDRC funding was secured, the project leader had said to his brother in Freetown: "It would be a shame to pull out, can you help me, others have failed, nothing has lasted for more than a year, can you help me to meet this challenge." At the end of my stay, I visited this brother in his home: he was a widower sharing a bedroom with three other men, his teenage daughter was sleeping in the hallway, and there was no electricity or telephone.

Questions regarding the nature of the project were also put, before the field visit, to IDRC head-office personnel who had been involved with the project. From the three interviews, the following response could be put together.

> It is basically a demonstration project: in fact, we have a kind of subsection dealing with demonstration projects in the Rural Water Supply and Sanitation Section of the Health Sciences Division. We have had or are envisaging projects like this in about 10 other countries.
>
> The basic research question is how to motivate people — how to educate a community to take care of its own needs in terms of water and sanitation facilities. We suggest to the local researchers that they take a sociocultural and environmental survey to start with, that they get community leaders involved, then that they install a few facilities. We can help with this but basically the local people should do it using local materials.
>
> It is important to sensitize people to what is coming, and to make the appropriate match between technology and culture. Also, the community must be educated in the usage and repair of the facilities.
>
> Many of these projects have failed, including some that we have supported. Even with such simple things as wells and latrines, there are many "dry holes" around the developing world. Thus, it is important to take another survey afterwards to document the differences in behaviour.
>
> Another problem is that when the team has a "good idea" for the technology of wells and latrines, they can become lost in the technology. The constructions can become too sophisticated and it is not possible for the villagers to repair, understand, or replicate them.
>
> This was an experiment — and a risk — for us too because, in this case, we started with a group [CDC] that had little experience, but wanted to get people to help themselves, and wanted to use local materials.

Can an NGO successfully accomplish an R&D task? The Ottawa staff put it this way.

> We know that, in many places, the government is too busy with the urban people at their doorstep and they cannot properly take

> care of rural areas. We also know that when we fund academics to do research it often produces nice reports but little that improves peoples' lives, especially the lives of rural people.

Thus, IDRC wanted to know, and this could be seen as a broader definition of the project, whether people in a rural area can solve their own problems with the help of an NGO rather than waiting for the government to act. In the past, NGOs were mostly involved in technical assistance: the question that IDRC wanted addressed was whether they could also do basic research in the sense of finding answers that might work, testing them by implementing a program, and monitoring their own achievements.

DETERMINANTS

Having described the project and its history, this section analyzes the determinants of the specific R&D process under consideration. It is easy to list the determining agents, starting with CDC and IDRC, but considerably more difficult to analyze their respective roles in the causal process, let alone the interaction effects among agencies. Researchers sometimes adopt methodologies of multivariate analysis using computers to analyze the respective causal influence of various factors and their interactions. There is disagreement in the social sciences regarding the extent to which such an approach leads to conclusive results. In any case, the present case does not lend itself to such a multivariate approach. However, the objective is the same: to analyze the various determinants, their relative weights in the causal process, and possibly their interaction effects in this process. The analysis will have to be a "judgment call" on the part of the researcher. After documenting that judgment call as far as possible, it is left to the reader to decide the extent to which the researcher has reached appropriate conclusions.

CDC, and especially its leader, should be viewed as the first agent in this analysis of the determinants. That was evident in the previous sections: the initiative, the motivation, and the coordination of the project are roles that were performed mostly by CDC, which might best be described as a small group of like-minded people interested in community development who, to achieve their objectives (especially that of obtaining the cooperation of other agencies), set themselves up as a nonprofit NGO. CDC also had, or had access to, certain expertise in site selection for wells, in well and latrine construction, and in health education.

IDRC would appear to have been another essential agent in the process. Adequate state funds were not available, and agencies of government that had the role of improving health facilities could see no reason to divert funds to an NGO.

As well as playing the role of a funding agent, IDRC oriented the project into a research mould. By viewing the scheme as a demonstration or test case, IDRC helped CDC to define the problem and to adopt an appropriate methodology.

In a broad sense, CDC's members had a very important research question in mind: what approach and what specific activities would enable villagers to improve their own living conditions, to become self-reliant, and to reduce emigration from the villages? They had various ideas regarding what might be done: small-scale industry, education, and health. Had they not received the input of IDRC's personnel, these implicit questions would not have been directly addressed. In particular, IDRC oriented CDC to view its project as a "demonstration," to "see if it would work." Thus the monitoring of conditions before the project and the evaluation of its impact came to absorb a considerably larger part of the attention of the CDC's personnel. Because they were using approaches whose features needed to be worked out with regard to feasibility — including the approach to use in dealing with villagers, design of wells and latrines, types of materials and labour, and content and format of health education — it would appear that the adoption of this kind of "research mode" was very beneficial to the project.

Moreover, it was an approach likely to minimize professional jealousy on the part of other organizations who might think that CDC was doing "their job" of helping the villagers. As long as CDC could say that it was just doing research and that ultimately the results of this research would be freely available to other organizations that might want to use them, the chances of hostility developing and possibly undermining the project were considerably reduced.

Having assessed the roles of CDC and IDRC as determinants, the next consideration is the villagers themselves. In one sense, the villagers are the main agents because they constructed the latrines and wells mostly by themselves, using local supplies, materials, and labour, with a little external help and advice. Nevertheless, they were not the initiating agents. Although they were generally quite conscious of the problems of their traditional water sources, and of the advantages of cleaner water, especially for drinking, they had rarely built wells and latrines for themselves. Worse than that, they had experienced, or had noted in other villages, failures in well construction — after much hard work, sometimes prompted by external agents, they had received only short-term benefits and soon the wells became polluted or went dry. The initial stages of this project had, therefore, to overcome the fear of failure that resulted from past experiences. The conclusion of this section suggests some reasons why other projects failed.

Several other agents besides CDC, IDRC, and the villagers also played a part. It is interesting that the leader's speech to the opening ceremony first acknowledged the President of the country, then the "Paramount Chief of the chiefdom and his Councillors and elders of this community." The Paramount Chief is, in fact, the honorary chairman of CDC. The reference here is to the traditional authority structure of the rural society. Later in this speech, a number of other institutions were acknowledged, including the NTC, CARE, the Tikono Agricultural Extension Centre, the Ministry of Social Welfare and Rural Development in Bo, the Ministry of Health, and the Njala University College. As a member of IDRC's head-office staff put it, and as I tended to confirm in the field visit, some of these acknowledgments are for public relations reasons, a form of quiet diplomacy calculated to get the appropriate support and to avoid possible conflicts of interest.

Another way to analyze the determinants is to know why other projects have failed or met with less success. From the early field trip reports and letters, one gathers that there were difficulties even in the choice of villages because they were affected by similar projects that had failed. In one small town on the road to Freetown, I noted a well that looked sturdy and beautiful, but it was not being used: it was not covered and the water was polluted. Besides problems caused by lack of covering, wells can cave in or go dry because of improper construction. In one village, two wells dug by the villagers with great effort had run dry. They had found a spider at the bottom and decided that the village was subject to some kind of sorcery in which a spider could drink up all the water from the well — it was very difficult to convince the villagers to try again with a new kind of well. Of course, if the well uses complex mechanical devices, these can fail and the villagers may not be able to repair them, or may not be able to afford the fuel to run a powered pump.

If a foreign agent comes in without gaining the consent of the village, the villagers may sabotage the project. A feature that many of these failures have in common is that foreign agents come in and do things that are not appropriate for the village; they simply build something and leave. Without follow through, there is a reasonable chance that some problem will emerge and that it will not be corrected by the local people. Thus, even if the survey and health-education components of the project accomplished little else, they at least forced CDC as a "foreign" agent to become acquainted with the community and to come back to the community after the project was completed.

CONCLUSION

Much of the research associated with developing countries makes exaggerated claims with regard to its potential impact on development. Rarely are these claims followed up to assess the real impact. Instead, the researchers move on to the next proposal. Of course, identifying the true benefits and their determining factors is difficult, but we should attempt more often to determine which of our projects have potential and which are essentially "dry holes." Development is very difficult — often it does not work and there are many "dry holes."

IDRC has a specific interest in such questions. It views its mission as neither pure research nor pure development, but as research for development. Research can include "trying something out to see what happens." IDRC is a relatively small funding agency and it has a preference for small projects. It likes to fund local researchers to do their own projects, helping them to define the problem and establish an appropriate methodology, and helping to monitor the project and its dissemination. More than that, this approach probably corresponds to the Centre's belief that small projects are best and that development occurs in an incremental fashion.

At first, I had some concern about assessing the present project because the unique personality of its leader may have made it impossible to replicate. However, the success of most projects depends on their leaders — that characteristic is not unique to community development.

In my judgment, the project under investigation was a "success." Although the data-gathering operation was of poor quality, there are now functioning wells and latrines in three villages of some 350 people each that did not have them before; people are probably more conscious of elements in their environment that affect their health; they are proud that they basically did this themselves and that other villages want to do the same things; and the project was administered correctly. CDC has learned a considerable amount about research and scientific methodology and better data can be collected later to document the impact.

I also think my reporting mission was a success. I posed difficult questions at the outset of this project and these are now resolved in my mind. I think I have found a "jewel in the bush" and I am very privileged to be able to tell people about it.

CHAPTER EIGHT

RURAL AQUACULTURE IN INDIA*

In 1974, the Central Inland Fisheries Research Institute (CIFRI) of India and IDRC worked out a project to test fish-farming technology under village conditions in the states of West Bengal and Orissa. The budget was CAD 324 000 for 3 years, but work actually continued from 1975 to 1979. Funds were channeled through the Indian Council for Agricultural Research (ICAR). The Government of India had already placed heavy emphasis on the development of fish culture in its Fifth Five-Year Plan. CIFRI had developed a package known as the composite fish culture system and had demonstrated its potential by an extensive series of trials on research stations throughout the country. IDRC felt that the technology was promising and encouraged CIFRI's proposal to test whether the station results could be maintained in farmers' ponds and whether it was profitable and acceptable to the owners: the research verified these questions. This chapter presents evidence that the effects of the project have been sustained with the original people involved in the project and have spread to neighbours, other villages, and beyond. IDRC's input to an intensive and sustained national effort was relatively modest, but was made at the critical stage of moving from station conditions to village life.

INTRODUCTION

By the end of this century, domestic demand for fish in India is expected to exceed 12.5×10^6 t/year and may even reach 20×10^6 t. The marine catch is expected to account for only half the supply, however,

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******This chapter is based on a report prepared by Professor Uma Kant Srivastava, Indian Institute of Management, Ahmedabad, and on field survey work carried out by Industrial Development Services, New Delhi.*

with the balance coming from inland waters. Although production of freshwater fish has tripled during the past two decades, it will have to increase seven-fold by the year 2000 to satisfy even the lower level of projected demand. At present, only one-third of India's total production of fish — 0.9×10^6 t — comes from inland waters.

Aquaculture or fish farming, however, has the potential to increase inland fish production considerably, thereby providing much needed edible protein and augmenting the income of rural communities. This potential has been emphasized at many scientific meetings, including a seminar on aquaculture in Asia sponsored by IDRC in April 1973.

The still water of ponds is more suitable than the flowing water of rivers or estuaries for the introduction of aquaculture technology. India has about 1.6×10^6 ha of pond water suitable for cultivating fish, yet a recent study estimates that only about 21% of the potential area is being used for fish farming, despite the existence of appropriate technology since 1962. The problem lies in testing and transferring the technology of intensive fish culture from the laboratory to the actual village pond.

The Central Inland Fisheries Research Institute (CIFRI), which falls under the aegis of the Indian Council of Agricultural Research (ICAR), is one of the world's leading freshwater research institutions. Up to 1975, it carried out experimental work on a composite fish culture (CFC) system, which it found could produce up to 9000 kg/ha per year, under ideal conditions, against the Indian average of 600 kg using traditional methods and species. The basic principle of CFC is that, when ponds are stocked with compatible fish that have different feeding habits, they yield a greater volume of fish than when they are stocked with an equal number of a single species.

THE TECHNOLOGY

The CFC system developed by CIFRI consisted of raising three Indian carp — *catla*, *rohu*, and *mrigal* — in the same pond with three exotic carp — Chinese silver carp, grass carp, and the Indonesian strain of common carp. In general, each species does not compete with the others for food or living space and some have beneficial effects on the growth of the others. The grass carp, for example, converts plant material into fish flesh and at the same time, its excrement fertilizes the pond, producing plankton that serves as food for another species.

A prerequisite for the development of CFC is the supply of a large number of fish eggs, which Indian scientists have been able to produce on a large scale. Brood stock of the desired species are given special care until the breeding age and season are reached, then combinations of one female and two males are injected with a hormonal preparation that results in the final stages of egg or sperm formation. Either natural spawning is allowed to occur or the eggs and sperm are stripped from the adult fish, mixed together, and placed in a simple hatchery. When the eggs hatch, they grow to the fry stage and are then stocked in specially prepared nursery ponds. The young fish are then ready for use in the composite culture system.

Before introducing CFC to a pond, however, soil and water conditions are determined and *mahua* oil cake is added to eliminate fish snails and other undesirable aquatic creatures. This biodegradable compound loses its toxicity within about 12 hours and has the additional advantages of fertilizing the pond. Supplementary fertilization may be achieved by adding cow dung, urea, or triple superphosphate to produce the desired plankton that serves as an initial source of food for the young fish.

Depending on the type of pond, its location, and the availability of fish eggs, various rations of the six species of fish are stocked at an overall rate of 5000 fish/ha of water area. A supplementary food mixture of oilseed cake and rice bran is sprayed daily on the water surface. Aquatic weeds available from local rivers, ponds, or tanks, together with other vegetable waste, are also added as food for the grass carp.

THE PROJECT

In 1975, CIFRI began a project to try out this technology under village conditions. All previous research had been done "on station." IDRC support was channeled through ICAR, the official recipient of funds.

The objectives of the project were to develop a highly productive CFC system, establish and evaluate experimental systems in village ponds at various locations in Orissa and West Bengal, and identify the principal constraints to improving composite culture.

CIFRI undertook to promote aquaculture in selected villages in the target area; study the nutrition of cultivated fish with special reference to feed formulation and fish pathology, which have a direct bearing on production; form a fishermen's cooperative society at each centre; train fishermen and other villagers in aquaculture techniques; and conduct netting demonstrations.

The project covered seven centres in West Bengal and five in Orissa, and included 160 ponds covering an area of 50 173 ha. Almost all the ponds selected were very small, rarely exceeding 1 ha, and their productivity was extremely low — less than 1000 kg/ha per year.

The states of West Bengal and Orissa in India were chosen as testing regions for four reasons.

- CIFRI's headquarters are located in West Bengal;
- These two states are part of northeastern India, the main fish-eating area of the country and a place where traditional aquaculture has been widely practiced;
- Fish prices had increased very rapidly making it difficult for the poor to obtain good quality fish; and
- These two states have the largest number of ponds and the second and fifth largest areas of fresh water respectively.

It was decided initially to select two project centres in each state. As the project progressed, other centres in each state were included for experimentation (Fig. 1). The selection was based on

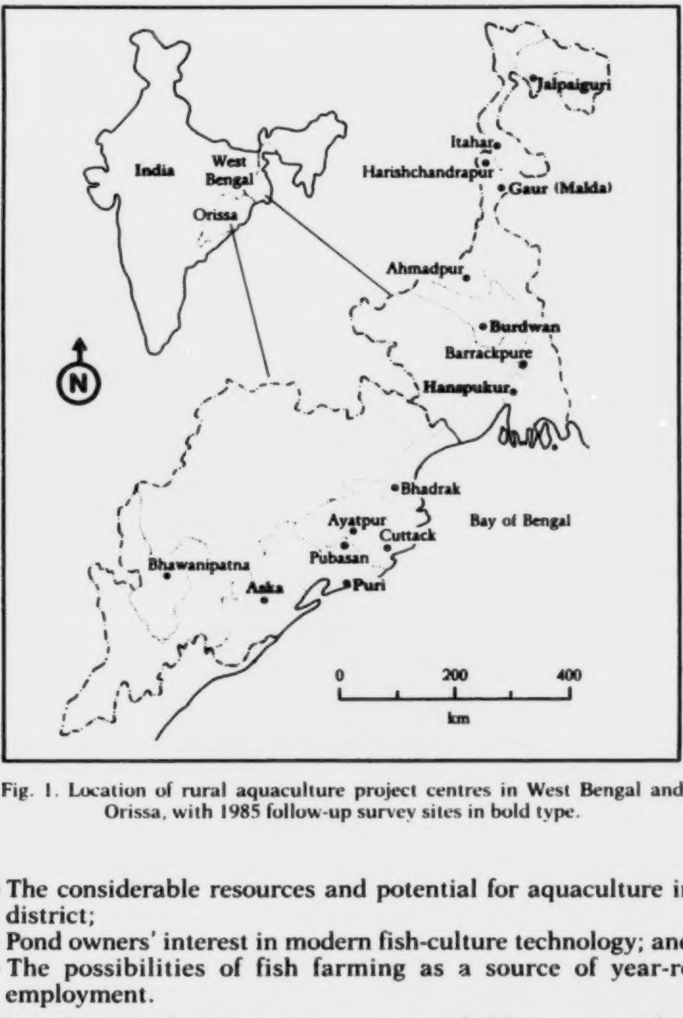
India
West Bengal
Orissa
Jalpaiguri
Itahar
Harishchandrapur
Gaur (Malda)
Ahmadpur
Burdwan
Barrackpure
Hanspukur
Bhadrak
Ayatpur
Cuttack
Pubasan
Bay of Bengal
Bhawanipatna
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Fig. 1. Location of rural aquaculture project centres in West Bengal and Orissa, with 1985 follow-up survey sites in bold type.

- The considerable resources and potential for aquaculture in the district;
- Pond owners' interest in modern fish-culture technology; and
- The possibilities of fish farming as a source of year-round employment.

The selection of project sites was preceded by a comprehensive benchmark survey conducted in both West Bengal and Orissa. Covering 62 villages, it indicated that most ponds were very small — 0.13–0.17 ha — and that their annual productivity, even that of the large ones, was extremely low — ranging from 70 to 700 kg/ha — compared with CIFRI technology that was capable of producing 6000–9000 kg/ha per year.

The ponds selected for experimentation ranged from 0.1 to 1.5 ha in area, were located within a reasonable distance of one another, and were within a radius of 15 km of the project centres. They were accessible year-round to ensure effective supervision, economy in transport of materials and equipment, and quick communication between the centres and the state headquarters. As well, the ponds had to be relatively immune from flooding, not in need of major reclamation, have a regular shape, contoured embankments, and a depth of at least 1.5 m in the summer.

PROJECT IMPLEMENTATION

Farmers, public and private institutions, and community associations were approached and persuaded to allow their ponds to be used for experiments. CIFRI fishery scientists and senior research assistants responsible for organizing and directing the work at the village level provided feed, fertilizer, and fish eggs together with technical knowhow. They demonstrated techniques of fish breeding and rearing, CFC, and air-breathing fish culture. The pond owners arranged for the care of the fish and received all proceeds from the harvest of fish in the 1st year. They were expected to use these proceeds to pay the costs of this system in the 2nd year, with CIFRI providing only technical assistance free.

Production was increased at all the test sites but was variable both between centres and within centres (Table 1).

Detailed studies by CIFRI of production costs and returns in 138 trials on their research stations, with yields ranging from 3900 to 6600 kg/ha per year, indicated that the average income per hectare from the trials in West Bengal was INR 27 973 and exceeded INR 20 000 in 14 of the 15 districts. (At the time of the project, 1.0 Indian rupee [INR] = 0.14 Canadian dollars [CAD].) Expenditures averaged INR 11 445/ha with little variation in input costs. The average cost of production was INR 2.62/kg of fish, with a maximum of INR 3.50. With an average sale price of INR 6.39/kg, the improved technology was clearly extremely profitable. The profitability of using this technology in farmers' ponds has been confirmed by a recent study on inland fish marketing in India.

POSTPROJECT DEVELOPMENTS

After the "lab to land" experiment in 1975–78 was completed, a field survey was carried out in 1985 to determine whether the farmers who had benefited from the project were able to sustain a major increase in yield over the traditional system. The study covered about half the ponds and owners involved in the original project: 34 randomly selected

Table 1. Sample project results in terms of fish yields.

Location	Production range (kg/ha per year)
West Bengal	
Hanspukur (1975–76)	3561–6033
Harishchandrapur (1975–76)	1780–4900
Gaur (1976–77)	2745–9060
Burdwan (1977–78)	3643–6732
Jalpaiguri (1977–78)	2157–4890
Orissa	
Aska (1976–78)	1907–6330
Puri (1976–78)	1330–4752

villages in six districts — four in West Bengal and two in Orissa (Fig. 1). The study team also visited a number of nonbeneficiaries who were aware of the project and had adopted some of the technologies introduced in neighbouring villages (see appendix).

The follow-up field survey produced results on numbers of ponds, areas of ponds, production, and income. It covered 43 private, communal, or institutional producers, who had had 78 ponds at the time of the project — 10 years later, these owners have 262 ponds of which only 3 were not in production at the time of the survey.

Forty of the pond owners, who had a total of 25 ha under fish production at the time of the project, now have 287 ha. These can be grouped as

- 19 owners who had no growth in water area;
- 15 owners who added a total of 18 ha;
- two private owners who increased the production area by 64 ha; and
- four *panchayats*, or village councils, who added a total of 179 ha.

Thus the pattern of increase appears to have been quite skewed: a few producers expanding in a major way but most growing slightly or not at all. It should be noted, however, that the total preproject pond area of the 15 owners in the second category was less than 8 ha, so in fact they more than doubled the size of their business.

Production data were more difficult to obtain and generalize; therefore they are presented by the four categories given above.

- Of the 19 "no-growth" pond owners, 11 increased total fish production from 3835 kg (1975) to 8182 kg (1985), i.e., more than doubling it from the same area.
- Of the 15 who more than doubled the area under production, 11 also increased their yields. Total production rose from 8368 kg (1975) to 45 115 kg (1985), a more than fivefold increase.
- The two large private owners are now producing a total of about 330 000 kg of fish per year compared with 5000 kg before the project. Their yields have gone up from 1500 kg/ha to around 4500–5000 kg/ha. However, this is lower than the 6000 kg/ha measured during the project.
- The four *panchayats* have control of large bodies of water known locally as *jheels*. These are found in low-lying areas that become flooded during the monsoon, receiving overflow from nearby rivers and are now used for raising fish. The total production is now estimated at 283 650 kg/year from 182 ha, compared with 3000 kg from less than 3 ha before the project. These yields are more than 50% higher than those obtained before the project, but considerably lower than the 3000–5000 kg/ha obtained during the project.

Precise changes in income could not be measured during the follow-up survey. However, several factors indicate that net incomes are considerably higher than preproject: there has been a rapid rise in the price of fish (higher than the rate of inflation), several government programs and subsidies have helped to keep production cost increases down, and it appears as though most producers are using lower levels of inputs than during the project period, yet still obtaining higher yields than they were before (although none as high as those measured during the project).

As in many economic matters, the "proof of the pudding is in the eating": individuals and communities have come to their own decisions about costs and returns, and 10 years later are still actively in production.

ADOPTION BEYOND THE PROJECT

The follow-up study identified two organizations, the Child in Need Institute (CINI) and the Socio-Economic Development Program (SEDP) of West Bengal, who had participated in the CIFRI–IDRC project. They have been training people in aquaculture as part of their rural development and nutrition programs. They stated that hundreds of small-farm families are now growing fish for their own consumption and for sale.

Some of the original project beneficiaries became technology lenders. To sell the fry or fingerlings, they trained people in the rearing of fish in their own or lessors' ponds. In one case, it was found that one person alone had helped 50 others, mostly young and educated, to practice aquaculture.

The project also influenced national policy and programs concerning fish culture in fresh water. One of the most important developments has been the establishment of fish-farming development agencies (FFDAs), which are expected to popularize aquaculture and make it more economically viable, provide training, and utilize hitherto untapped freshwater resources to strengthen the rural economy. Although the first FFDA was set up in November 1973 in Mysore district in Karnataka, it was only after CIFRI was able to demonstrate convincingly, with IDRC's assistance, the possibilities of higher yields and incomes from CFC and *magur* (air breathing) culture that national and state policymakers would support the FFDAs.

In 1979, 15 FFDAs were transferred to a World Bank pisciculture project in five states — Bihar, Madhya Pradesh, Orissa, Uttar Pradesh, and West Bengal. In 1980, 43 new FFDAs were established under this project and, more recently, the state governments have established FFDAs of their own.

The most recent reports are that the FFDA program has to-date brought 35 573 ha of water area under fish culture in West Bengal and 15 634 ha in Orissa. Under the program, 36 000 and 9000 producers were trained in West Bengal and Orissa respectively. By 1990, it is proposed to establish 350 FFDAs, covering an area of 196 000 ha in the country.

Another feature of the spread of the technology was that a large number of people who were not fishermen by occupation and did not own ponds took up fish farming as a commercial proposition. These people usually leased ponds on a long-term basis, sometimes up to 10 years, acquired the necessary know-how, and invested substantially.

APPENDIX — AN EXAMPLE OF ADOPTION BEYOND THE PROJECT

Mr A. Ali was a civil contractor in Malda. Until 1975, fish farming was a subsidiary occupation for him. He owned some ponds in Malda district where fish were raised by traditional methods.

Mr Ali was not a beneficiary of the CIFRI–IDRC project. However, his interest in scientific fish culture was aroused as a result of the CIFRI–IDRC project organized in Malda district during 1976–77. Although his pond was not taken under the CIFRI–IDRC project, he showed keen interest in obtaining information and gaining experience on modern fish culture techniques. He attended seminars and demonstrations that were organized during the course of the project and also consulted CIFRI scientists to obtain further technical advice. He was mainly attracted by the higher yields and income associated with the new technology. He subsequently started developing a large area for fish culture and set up nurseries to breed fish, produce fry and fingerlings, and raise fish.

Investment

At present, the total value of Mr Ali's investment in fish culture activities is estimated at INR 700 000 or CAD 11 400. He has 30 ponds with a total water area of 20 ha of which 17.33 ha belong to him and 2.67 ha are leased. He also has 7.5 ha of agricultural land where paddy, mustard, etc. are grown. In 1984, Mr Ali invested in a modern hatchery costing INR 70 000.

Technology used

Mr Ali continues to follow the technology introduced by the CIFRI–IDRC project and applies the recommended doses of inputs required for scientific fish culture. He has also modified the new technology to suit his requirements.

Employment

Mr Ali's fish farm employs 20 individuals on a regular basis and additional labour is hired as needed. Mr Ali spends INR 75 000/year on wages of his employees. This does not include payment for netting given to professional fishermen: they are paid a commission on the sale of fish harvested.

Demonstration and training

Mr Ali has been assisting small fish farmers and unemployed youth in and around Malda and encouraging them to take up scientific fish culture. He demonstrates various aspects of the modern technology to them and offers them technical advice. He also supplies fry and fingerlings to small farmers. He has contributed significantly to the dissemination of the new technology among fish farmers. He has given up his successful business as a contractor to devote his full time to fish farming.

Plans for the future

Mr Ali is planning to have a large Chinese type of hatchery that will enable him to increase production of spawn, fry, and fingerlings many fold. To ensure the sale of these items, he is also going to increase his "Private Extensive Services" to induce more educated young men to take up aquaculture on a commercial basis.

CHAPTER NINE

ORAL REHYDRATION THERAPY IN THE PHILIPPINES*

Between 1980 and 1983, IDRC supported attempts in Southeast Asia to increase the proper use of oral rehydration salts to combat the effects of diarrhea by developing better packaging, labeling, and instruction materials. The funds (CAD 450 000) were channeled through the Program for Appropriate Technology in Health (PATH) to local agencies in Bangladesh, Indonesia, the Philippines, Sri Lanka, and Thailand. (PATH is a program of PIACT — the Program for the Introduction and Adaptation of Contraceptive Technology — a mainly Third World entity created with support from the Ford Foundation.) This chapter deals with the experience in the Philippines, where the project was carried out by the Kabalikat ng Pamilyang Pilipino, a private foundation that conducts research to improve the understanding of health products and services by the Filipino family. The research was not dramatic, sophisticated, or expensive: basically, Kabalikat tried to find out what kinds of pamphlets and labels would ensure correct use of oral rehydration therapy (ORT). The work is unfinished, but some of the products — a physician's manual and a user's pamphlet — are beginning to be used. It cannot be said that this project by itself has saved lives: indeed the extent to which reduced levels of morbidity and mortality from diarrhea are due to the entire ORT effort is unknown. However, ORT is known to be making a contribution, and this chapter outlines how the Kabalikat research in its turn is an important part of a wide-ranging series of initiatives.

**This chapter is based on a report prepared by Dr Rogelio V. Cuyno, Director, Research Management Centre of the University of the Philippines, Los Baños, with assistance from the Kabalikat ng Pamilyang Pilipino Foundation, Manila.*

THE PROBLEM: ACUTE DIARRHEAL DISEASES

Diseases characterized by acute diarrhea have long been recognized as a major health problem in developing countries. In spite of medical advances in their treatment, they remain a significant cause of death, mostly due to dehydration or the loss of water and electrolytes beyond the body's threshold of tolerance.

Recent estimates by the World Health Organization (WHO) indicate that, in Africa, Asia (excluding China), and Latin America, 750 million children aged less than 5 years suffer from diarrhea annually and a total of 4.6 million of these children die from it. In the Philippines, diarrhea is the second leading cause of morbidity and death in this age group and the third leading cause of infant mortality.

In diarrhea, the small intestine loses its capacity to absorb water and electrolytes and instead secretes electrolyte-rich fluids. Fluid loss of up to 5% of body weight produces thirst, but generally no other symptoms. Greater loss causes a weak rapid pulse, a loss of skin elasticity, low blood pressure, reduced urinary output, and severe thirst. With a fluid loss of more than 10%, shock may set in, stupor occurs, kidney function is disrupted, peripheral blood vessels collapse, acids build up (metabolic acidosis), and death follows.

Most acute diarrheas are caused by one of a wide variety of bacteria, viruses, and parasites — including rotavirus, *Escherichia coli*, shigella, salmonella, and cholera.

Infants and young children are particularly susceptible to dehydration from diarrhea. Their higher rate of body metabolism (about two to three times higher than that of adults), relatively large surface area, and immature kidney functions result in a higher daily turnover of water and electrolytes. These normal daily losses are exacerbated by the occurrence of diarrhea, vomiting, and sweating.

In addition to causing acute dehydration, repeated episodes of diarrhea impair nutritional status in several ways: the child loses appetite and eats less, parents may withhold food from the sick child, nutrients are poorly absorbed by the intestines during and after the diarrheal episodes, and body tissues are broken down metabolically. With repeated diarrheal attacks and ever-worsening nutritional status, the child becomes more susceptible to other acute infections. Thus, diarrhea and associated malnutrition are a significant factor in deaths attributed to other causes.

TACKLING THE PROBLEM: ORAL REHYDRATION THERAPY

The death rate would be even higher, however, were it not for the advent of oral rehydration, or fluid, therapy (ORT), which is fast gaining popularity in developing countries where it has revolutionized the management of diarrheal dehydration.

The feasibility of ORT was dramatically demonstrated during the 1971 civil war in Bangladesh. A cholera epidemic raged through West

Bengal's refugee camps, affecting a large number of people who were too far from established treatment centres to receive intravenous therapy. Although ORT had been tested only in clinical settings and in relatively small, carefully monitored field trials, it was the only practicable way to treat the numbers of people involved.

The Johns Hopkins Centre for Medical Research and Training in Calcutta set up and operated an emergency treatment centre near the India–East Pakistan border. Two of every five patients were children. Nearly all patients were dehydrated when they arrived; many were in shock and some in coma. To complement oral fluids, premeasured packets of salts were distributed in the refugee camps. These measures were successful and the death rate was a low 3.6%. After the Bangladesh experience, the use of ORT spread throughout the world and it was shown to be far less expensive than intravenous treatment and could be started in the early stages of diarrhea.

ORT was first tried in the Philippines in 1961 (Table 1), when the country was hit by a series of cholera epidemics. However, interest in the therapy declined with the control of cholera in the mid-1960s, although the disease accounted for only 5% of cases of diarrhea in the country.

Interest in ORT revived in 1975, however, when field trials started in Bacolod City in the Visayan Islands under the auspices of the Philippine government and WHO. In the 2-year study, an oral rehydration solution (ORS) known locally as Oresol (Table 2) was administered to children suffering from diarrhea.

Results showed that Oresol was highly effective and acceptable to mothers. The latter claimed that it improved the general state of health and appetite of their children and resulted in more weight gain, that its popular use in the community reduced hospital admissions due to dehydration, and that it could be distributed effectively by a local delivery system and could be used widely and safely. Mothers likewise realized the value of continued feeding during diarrhea.

During those years when ORT was being field-tested in Bacolod, diarrhea remained the second leading cause of death and illness in the country, with a mortality rate of 2.1 per 1000 population and a morbidity rate of 19 per 1000 in 1978. Almost 50% of all reported cases and 75% of deaths from diarrhea occurred among children aged less than 5 years. Considering that 17% of the estimated 50 million population of the Philippines was in that age group, the magnitude of the diarrheal disease problem in the country became more evident and pressing.

The Bacolod field tests paved the way for more studies on ORT and, by February 1978, Oresol was distributed region-wide to rural health units and to emergency hospitals.

The responses were consistently favourable among the communities where Oresol therapy was implemented, thus encouraging the Ministry of Health (MOH) to embark on a program of mass production and distribution of the treatment, which eventually became the core activity of the national program for the control of diarrheal diseases (CDD).

Table 1. Oral rehydration therapy in the Philippines: a chronology of events.

Year	Events
1961	Oral rehydration therapy (ORT) first tried in the Philippines during cholera outbreak. Clinical trials at the San Lazaro Hospital in collaboration with the World Health Organization (WHO), United States Naval Medical Research Unit, and the Ministry of Health of Japan
1964–1972	Philippines–Japan–WHO cholera research projects
mid-1960s	With cholera under control, interest in ORT declined; cholera research projects went on until 1972
1973	Dr Arturo Ludan did a study on oral rehydration solutions
1975–1977	ORT introduced during field trials in Bacolod City. People received WHO-recommended formulation of oral rehydration salts, locally known as Oresol
1975	The Bureau of Research and Laboratories began mass production and free distribution of Oresol
1976	WHO launched a global program for the use and delivery of ORT — the diarrheal diseases control program
	Beneficial effects of ORT revealed in Bacolod studies encouraged officials to expand ORT promotion, starting with pilot areas in each of the 12 health regions
1980	The Ministry of Health (MOH) adopted a national control of diarrheal diseases (CDD) program with ORT as a vital component
1981	Integration of the national CDD–ORT program into the primary health care program
	Regional consultative training workshops
	Kabalikat ng Pamilyang Pilipino received funding from IDRC to develop support print materials to promote ORT
1982	Program review
	Training on clinical management of diarrhea held at the International Centre for Diarrheal Diseases Research in Bangladesh
1983	Prototype copies of user pamphlet and ORT product label printed and evaluated by Kabalikat
	One million copies of final prototype user pamphlet produced by MOH
	Five hundred prototype copies of physician's manual and 1000 prototype copies of fieldworker's pamphlet printed
1983–1987	Five-Year Plan: the Government of the Philippines through the MOH made promotion of ORT a national health priority
1984	Overview assessment of ORT program done by interdisciplinary team to determine areas of program assistance by United States Agency for International Development (USAID)
1985	Review of the National CDD–ORT program done by a joint team of MOH, USAID, WHO, and United Nations Children's Fund (UNICEF)
	Philippines government received grant of USD 4.2 million from USAID to promote the use of ORT for the prevention of death from diarrhea (21 June)

Launched in 1980, when Dr J.C. Azurin (one of the leaders in the Bacolod field study) became Deputy-Minister of Health, the CDD program was integrated 1 year later into the national primary health care (PHC) program of the MOH, thereby strengthening its implementation at the community level. Considered to be among the top priorities of the MOH, PHC is a nationwide undertaking inaugurated in September 1981 by the President of the Philippines.

PHC takes the following approach to the treatment of diarrhea: a volunteer *Barangay* Health Worker (BHW), chosen by the community itself, conducts diarrheal disease surveillance in the community with

Table 2. Components of Oresol.

Ingredients	Composition (g/L of water)
Sodium chloride	3.5
Sodium bicarbonate	2.5
Potassium chloride	1.5
Glucose	20.0

the assistance of *purok* (neighbourhood) unit leaders, who are also selected by the community, at the rate of 1 per 20 households. They distribute and administer Oresol to those suffering from diarrhea, and help midwives in the monitoring, referral, and follow-up of cases.

Production of Oresol by the Bureau of Research and Laboratories (BRL) increased from 0.6 million packets in 1979 — 1 year after CDD–ORT was launched — to 5.1 million in 1983, and that year the Government of the Philippines, through MOH, made the promotion of ORT a national health priority.

Until 1984, distribution to the regions was the responsibility of BRL. Recently, MOH's supply section took over distribution of Oresol along with other MOH drugs. Oresol is distributed directly by the central ministry in Manila to the health regions. From the regional health centres it filters down to the provincial health hospitals, municipal health centres, rural health units, and eventually to the *barangay* health stations, a network of outlets called *botika-sa-barangay*, and *barangay* health workers.

TRAINING AND PROMOTION: TWO FACTORS IN THE ORT PROGRAMS

TRAINING

In 1980, when the ORT program began, the MOH initiated a national campaign to educate its health professionals in ORT and the use of Oresol. The 1-day training session covered topics such as the nature of diarrhea, the importance of treatment and prevention, the management of acute diarrhea, and simple measures to prevent it using the PHC approach.

Under the direction of a task force on CDD, 41 regional trainers and 30 Metro Manila hospital and MOH personnel participated in the training session. The trainees were to relay what they learned to MOH personnel at the regional level who in turn were required to train provincial, municipal, and *barangay* personnel.

In mid-1981, the CDD task force developed a field survey to evaluate the status of the ORT program and obtain baseline data essential to the planning of future ORT activities and to estimate the impact of the therapy on diarrheal disease mortality and on intravenous use.

Results of the field study were disseminated in a series of regional consultative seminar workshops attended by 932 representatives from all 12 regions of the country.

PROMOTION

The Information and Education Communication (IEC) section of MOH developed several types of material to promote ORT to medical personnel and end users. Two thousand copies of two posters describing the use of Oresol were printed and distributed to rural health units and hospitals. The MOH, together with the Kabalikat ng Pamilyang Pilipino (Kabalikat), a private foundation that provides health-related support services, also produced a 20-page flip chart to convey information on the effects, prevention, and treatment of diarrhea. This flip chart served as an aid to the BHWs in promoting ORT to mothers. MOH, with the assistance of Kabalikat, designed another kind of instructional item to guide mothers in the use of Oresol: a one-page flyer to be distributed with the Oresol product.

Kabalikat, with funds provided by IDRC, also developed an improved label for ORS packets, a pamphlet for mothers, an ORT fieldworker's pamphlet, and a physician's manual.

A comprehensive assessment of the national CDD–ORT program in 1985 by a joint team of the MOH, the United Nations Children's Fund (UNICEF), the United States Agency for International Development (USAID), and WHO concluded that the promotion of Oresol throughout the country was well known at the *barangay* level by midwives and paramedical workers. Moreover, a field assessment of ORT in the northern Philippines in July 1985 by Kabalikat and the Research Management Centre found that 56% of the 174 Oresol users interviewed had seen some form of communication material on the product. The label and pamphlet had had the widest exposure (32.7% each), followed by the poster (19.2%), the flip chart (5.8%), and the leaflets (1.9%). Significantly, 82% of those who had received instructional materials said they read them. They suggested that the materials should include not only directions but also stress the necessity of taking Oresol. The field survey indicated that Oresol was very popular with end users because it was effective, free of charge, and easily available, and that a large number of patients were treated with Oresol at home instead of being admitted to hospital. Midwives were often mentioned as the most effective promoters of Oresol in terms of explanation and distribution of informational materials.

KABALIKAT'S ROLE

As mentioned earlier, information and education materials were crucial in promoting the use of Oresol. In developing the revised package label and user brochure, Kabalikat relied on numerous group discussions held with mothers to provide information and suggestions designed to ensure the selection of meaningful messages and symbols. The MOH subsequently produced one million copies of the final prototype pamphlet (Fig. 1). The pictures make it clear that both sides of the two-compartment package must be opened and poured into the water — the components must be kept separate during storage otherwise they spoil, but they must be mixed together for use. Earlier material had not

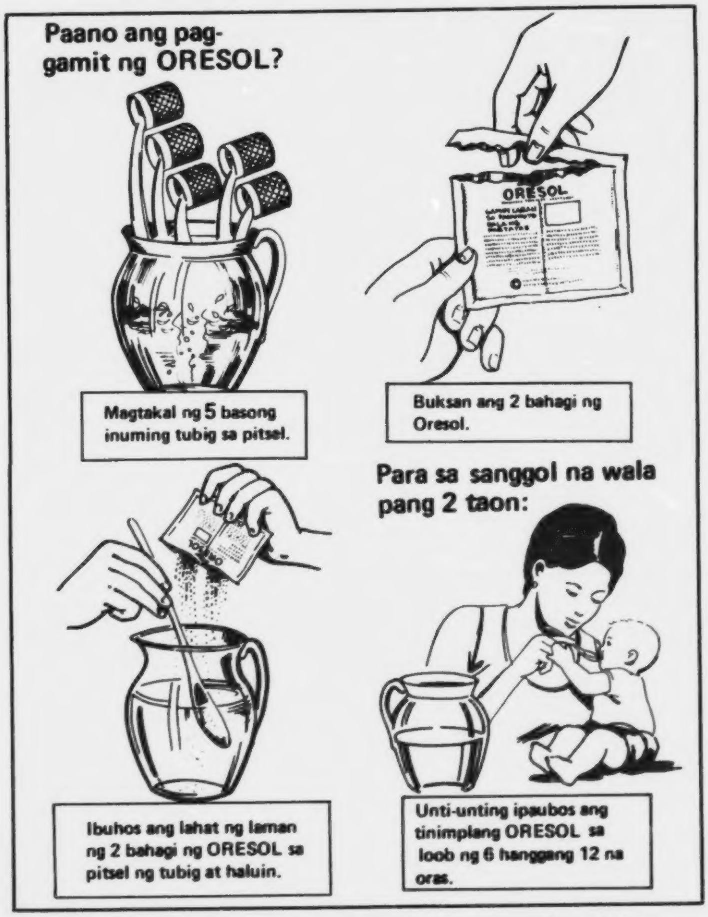

Paano ang pag-gamit ng ORESOL?
ORESOL
Magtakal ng 5 basong inuming tubig sa pitsel.
Buksan ang 2 bahagi ng Oresol.
Para sa sanggol na wala pang 2 taon:
Ibuhos ang lahat ng laman ng 2 bahagi ng ORESOL sa pitsel ng tubig at haluin.
Unti-unting ipaubos ang tinimplang ORESOL sa loob ng 6 hanggang 12 na oras.

Fig. 1. Some illustrations from the pamphlet prepared by Kabalikat.

made this clear and Kabalikat found that some users were only using one side at a time.

As part of the work supported by IDRC, Kabalikat also carried out an evaluation of the package label and ORT pamphlet, using experimental and control groups of rural mothers who had at least one child aged less than 5 years. The results indicated that the improved label was effective in increasing the proportion of mothers who prepared Oresol correctly on their first try from 4 to 22% and that correct preparation increased to 35% when respondents read both label and pamphlet instructions. This implies that more than 300 000 families could have benefited from use of the one million pamphlets together with the new labels. The error rate in opening the package was reduced from 40 to 7% by the combined effect of the pamphlet and package label.

Development of the fieldworker's pamphlet was based on data gathered from midwives and nurses as well as insights derived from group discussions held with doctors. The instructional material subsequently underwent rigorous testing until the level of comprehension among nurses and midwives reached 80%. Then 1000 prototype copies were printed.

The physician's manual was based on information supplied by local doctors, the WHO manual for the treatment of acute diarrhea, and a Johns Hopkins University publication on ORT for childhood diarrheas. The manual was then reviewed by a panel of eminent physicians and 500 prototype copies were printed. It is being used as a model in several other countries in the region.

EFFECTS AND EFFECTIVENESS: THE NATIONAL CDD–ORT PROGRAM

According to the 1985 CDD program review, diarrhea-related deaths in children appear to have been halved in the Philippines since 1978. It is not possible to say how much of this has been due to the increased adoption of ORT. It can only be noted that the technique has been proved effective in saving children's lives; that, between 1979 and 1984, 18.6 million packets of Oresol were produced and distributed; and that a nationwide effort has been made to ensure that the therapy is properly applied.

The results of several Kabalikat studies as well as reviews conducted in 1984 by the MOH and jointly in 1985 by MOH, UNICEF, WHO, and USAID show that much remains to be done, however, in promoting and explaining ORT and in distributing Oresol.

The 1984 study by Dr Jon Rohde on behalf of USAID showed that, although Oresol was familiar at the *barangay* level to midwives and paramedical workers, there were problems with supply, packaging, and taste. Advice was needed in cases where patients refused to drink the solution, and more doctors had to be convinced of the advantages of Oresol over antidiarrheal drugs. Dr Rohde suggests that affordable alternatives to the government ORS product be developed and made available at more distribution outlets.

The 1985 interagency review of the CDD program indicated that training in the clinical use of ORT remained inadequate and that the ORT message had to be reinforced. The review is also critical of distribution and notes supply shortages. It observes that medical personnel are not sufficiently familiar with Oresol and that use of mass media to reach the public at large had been minimal.

The field assessment of ORT in the northern Philippines noted that, although 88% of those who had used Oresol would use it again if necessary, MOH workers still found it difficult to change many mothers' and practitioners' preference for antidiarrheal drugs.

Meanwhile, implementation of the MOH oral rehydration program at the field level is in high gear and a comprehensive and coordinated promotional campaign for ORT is about to be launched with a grant of USD 4.2 million from the United States. The campaign will be aimed at all levels, from physicians to the general public, to stimulate demand for ORS in the management of diarrhea. A portion of the grant will be used to procure commercially manufactured ORS to be sold through the nationwide network of *botika-sa-barangay*. In so doing, the MOH will be making Oresol more widely available. It can be expected that the physician's manual and the other promotional materials researched and developed by Kabalikat will help to ensure that these efforts benefit the people for whom they are intended.

CONCLUSION

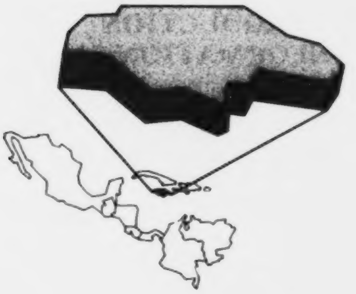
It was only in 1980 that the Government of the Philippines through the MOH committed funds, people, facilities, and other resources to promoting ORT on a national scale. The preceding 19 years had been devoted to research and development. It might appear that 20 years is too long a time for a good idea to catch on — particularly if it is something that could spell the difference between life and death. In the history of medicine, however, the ORT case is hardly isolated and unusual.

Among the factors that led to national action on ORT was the leadership of the Minister of Health, Dr J.C. Azurin, who was personally involved in the initial research, field testing, and regional piloting of the therapy before becoming minister. A major contributing factor was assistance from international development agencies such as IDRC, UNICEF, USAID, and WHO. The role of training and communication was undoubtedly important in bridging some of the gaps in knowledge and enhancing understanding of ORT.

Although the government has made a concerted effort to popularize Oresol country wide, sales of antidiarrhea drugs continue to be strong. Relatively expensive, premixed formulations, such as Pedialyte, and intravenous electrolyte fluids, which require hospitalization, are still a common treatment for diarrhea in government hospitals.

Among the weak spots that may have limited the impact of the CDD–ORT program are the taste of Oresol, its short shelf life, and the lack of sufficient resources to produce Oresol in adequate quantities and distribute it efficiently. Slow bureaucratic processes have aggravated the problem of insufficient resources, and the government policy of distributing Oresol free of charge has stifled private sector participation in the promotion of ORT. It is also claimed that the continuing education program and information campaign for medical practitioners have not been intense enough. Thus, physicians are now a major target group in MOH's invigorated program to promote ORT. Finally, some experts have observed that information campaigns aimed at changing public attitudes have not been sufficiently vigorous and the mass media have not been adequately tapped.

CHAPTER TEN



JAMAICA'S NATIONAL INFORMATION SYSTEM*

Recognizing the need to integrate, coordinate, and improve information services in Jamaica, the Prime Minister established the National Council on Libraries, Archives and Documentation Services (NACOLADS). One of the Council's responsibilities was to produce a plan for a national documentation, information, and library system. This was presented to the Government of Jamaica in 1977 and NACOLADS was authorized to implement the plan. IDRC contributed CAD 400 000 in a first phase to the National Library of Jamaica and the Socio-Economic Information Network. In 1983, IDRC approved a further grant of CAD 324 000 for continued implementation, particularly the Scientific and Technological Information Network. Other case studies in this book have attempted to trace effects on people's lives of research with which IDRC has been associated. Clearly this case is different: it does not concern investment in research, but in ways in which knowledge can be made available to people when they need it. "People" in this case covers not only researchers, but also politicians, planners, public servants, entrepreneurs, and the general public. Such investment does not have direct effects on development, and yet information systems are indispensable to the development process. This chapter does not pretend to identify or quantify any specific benefits in development terms, but provides persuasive testimony of the importance of this Jamaican initiative. The information needs of Jamaicans in all parts of society are now being better met, the human and material resources devoted to this task are being more effectively used, and there is growing awareness and excitement about the power that indigenous control over information brings to national development efforts.

This chapter is based on reports prepared by Dr Louis Vagianos of the Institute for Research on Public Policy, Halifax, Nova Scotia.

INTRODUCTION: INFORMATION AND THE DEVELOPING WORLD

In 1985, the United Nations Panel on Information Systems for Science and Technology for Development called attention to the importance of information for developing nations and urged its parent body to take immediate action to help Third World nations to develop such systems.

During the last few decades, it has become evident that information is the "master resource" of our time, the chief raw material and principal product of modern economies. The message is clear: whether rich or poor, nations wishing to improve their social and economic performance must develop and manage effective information systems.

This is a particularly difficult task, however, for developing countries. Merely attending to the basic social and economic needs of their peoples consumes all or most of their available capital, material, and human resources. Moreover, the concentration of production and management of information technologies in developed nations has raised the spectre of a new type of colonialism: information-systems dependency between developed and developing nations analogous to, and more serious than, the current instances of industrial reliance. For these reasons, helping developing countries to create and operate appropriate information systems is a priority of IDRC and the major sphere of action of its Information Sciences Division.

In considering the information needs of developing nations, it is important to realize that these needs vary by group and with circumstances and must be satisfied on that basis. For example, government departments and agencies require information on policies in other nations, on information flows, costs, trends, and innovations to formulate policy and make strategic management decisions. Research institutions and researchers need information on technology sources and technological alternatives, and on experiences with the use of different techniques and processes. Entrepreneurs, farmers, and the general public need specific information to improve the effectiveness of their own operations.

Over the years, a solid base of established research has documented the information difficulties of developing nations: sharp distinctions between the backgrounds and needs of urban and rural communities, lack of an adequate infrastructure — including an educational base on which to build the necessary training programs — and lack of an adequate network to diffuse the information. At the same time, there has been widespread agreement on the interrelated steps that must be taken to devise effective information assistance programs.

The first step is to distinguish between the needs of differing users. The second involves initiating a program of personnel training in library and information services so that programs to educate users can be developed. The third step is harnessing indigenous educational and information resources with a view to integrating them gradually into the formal information system and the fourth involves cooperation with external agencies to help provide access to the information files of developed nations. The final step is the formal commitment of governments to the organization of a reliable network delivery system. That such steps are extensive and costly in effort and resources must be appreciated by policymakers throughout the development community.

JAMAICA: THE INFORMATION ENVIRONMENT IN CONTEXT

With a population of 2.2 million distributed among 13 parishes across 11 400 km^2, the Caribbean island nation of Jamaica provides a valuable example of the problems and promises inherent in developing an effective national information system. Bauxite mining, tourism, and agriculture are the main economic activities, with the latter being the major employer. Although different, each of these activities requires and can benefit from the right information at the right time.

The Jamaican National Documentation, Information, and Library System Plan is less than a decade old and has evolved just as information systems development has reached a stage that allows a much easier application of technology than was previously possible. This circumstance means that aid projects can be created in which each participant can contribute the most appropriate blend of resources. It also means that a successful project in Jamaica can serve as a model to other developing nations as they plan and implement their own national information system.

In comparison with many other Third World nations, Jamaica has substantial infrastructural assets. It has sea- and air-transport links and is connected to the rest of the world through telephone, cable, telex, and satellite channels under the control of Jamaica International Telecommunications. The internal communications structure is relatively well established, with an automatic telephone exchange system, 4800 km of main roads, railroads, and a postal system. Like many developing countries, Jamaica has had to make a determined effort to eradicate extensive illiteracy and has also experienced shortages of basic materials required for economic, social, and technical development.

In addition to a sound communications infrastructure upon which to base the creation and implementation of a national information system, Jamaica has enjoyed other advantages. It has substantial bibliographical literature and government documents, many of which are unique. Similarly, the country is relatively richly endowed with archival materials and a distinctive cultural tradition that has been carefully preserved. It has also enjoyed a comparatively high degree of professional development in the information field, with an active university, a library school, and a library association. Jamaican information workers thus formed a receptive audience for the concept of information planning at the national level.

As well, the government has consistently urged and supported the development of a national information plan and has contributed, from the beginning, two-thirds of the total budgets for IDRC-assisted projects to develop national information systems, despite severe internal economic problems.

Because English is the national language of Jamaica, and one of the major languages of industry, commerce, and scientific research, it is easier for the island nation to relate its resources to those available elsewhere. When the time is right, this language compatibility will make "plugging in" to the worldwide network of information services (e.g., commercial data bases) much simpler.

Despite its advantages, however, Jamaica is no exception to the general observations made earlier concerning information systems in developing countries. For example, a perennial problem experienced by the Jamaica Library Service is an acute shortage of staff. The problem is endemic to both public and school libraries and among professional as well as support staff. Of the 91 professional positions in the service, only 27 have been filled. The deficiency is felt most keenly in the comparatively "new" areas of librarianship, such as audiovisual media and methods, research techniques, and automation.

NACOLADS AND THE DEVELOPMENT OF JAMAICA'S NATIONAL INFORMATION PLAN

Until the establishment of the national information plan, libraries and the central registries of government departments, although potentially rich in information resources, were unorganized, given scant attention, and generally staffed by unqualified personnel. Moreover, libraries and information departments in tertiary institutions had no coordinating mechanisms or agency to assure optimum use of their varied resources. No clearing house, no unified catalogue and referral machinery, and no rational, coordinated, and self-reviewing system of information resources existed.

This was the situation that the National Council on Libraries, Archives and Documentation Services (NACOLADS) had to address upon its establishment in 1973. By 1974, NACOLADS had a specific set of tasks to perform. First on the agenda was the creation of a national plan for the development of libraries, archives, and documentation services. Next was the establishment of a national depository library, followed by a review of Jamaica's library, archives, and documentation needs. NACOLADS would then be responsible for the stimulation and development of libraries, archives, and documentation centres in private organizations. The final item on NACOLADS' agenda was the specification of national standards for upgrading Jamaican information services and resources. The completion of this set of tasks was a prerequisite for preparing and implementing an integrated approach to information and its use in Jamaica.

In September 1974, the Jamaican Cabinet endorsed the authority of NACOLADS and accepted its objectives as policy. A meeting in Paris sponsored by the United Nations Educational, Scientific and Cultural Organization (Unesco) that same year adopted the concept and objective of national information systems.

In January 1977, the Council endorsed a work plan based on 10 working parties, each dealing with a type of library or a major topic of concern and chaired by a member of NACOLADS. The topics ranged from establishing national priorities to publishing, training, and audiovisual materials. Membership of the Council and its working committees permitted wide representation of information resource workers and users in the country.

By the end of the year, the plan for a national documentation, information, and library system for Jamaica was formulated and published. Acceptance of its provisions resulted in the creation of a National Library of Jamaica and the organization of library and information services into a series of operational networks according to subject area and community orientation. As a by-product of the planning process, NACOLADS became the permanent independent institution that provides a forum for the deliberation of network issues and whose recommendations go before Cabinet. Once approved, NACOLADS' recommendations have the authority of government.

THE NETWORK FOR IMPLEMENTING THE NATIONAL INFORMATION PLAN

Revised in 1984/85, the national plan has resulted in the integration of Jamaica's libraries into five main networks: the National Library of Jamaica (NLJ), the University of the West Indies (UWI), the Jamaica Library Service, the Statistical Institute of Jamaica, and the Jamaica Archives and Records Department (Fig. 1).

Within the NLJ network — the National Referral Service — are four subsystems: the Science and Technology Information Network (STIN), the College Libraries Information Network (COLINET), the Socio-Economic Information Network (SECIN), and the Legal Network (LINET). The chief library in each network is designated as its focal point with the National Library as the chief focal point for the entire system and NACOLADS providing overall coordination of policy and planning. Thus, the focal point for STIN is the Scientific Research Council; that for COLINET is the Library of the College of Arts, Science and Technology; that for SECIN is the Planning Institute of Jamaica's Documentation Centre; and that for LINET is the Supreme Court Library.

Within each network, services are targeted to meet the needs of clients known to be their chief users. Although the networks make up an integrated information delivery system, their components are, of necessity, developing at different rates.

Three central bibliographic data-base systems are intended to provide the major general support for the national plan. The first of these is the NLJ's central data-base system, which incorporates the four sectoral information networks and their component public and private sector libraries.

The Jamaica Library Service's central data-base system is intended to serve institutions in the public- and school-library sectors. Public and branch libraries and those in primary and secondary schools are currently served through the network, whereas those in basic, technical, and vocational schools under Jamaica Library Service jurisdiction are

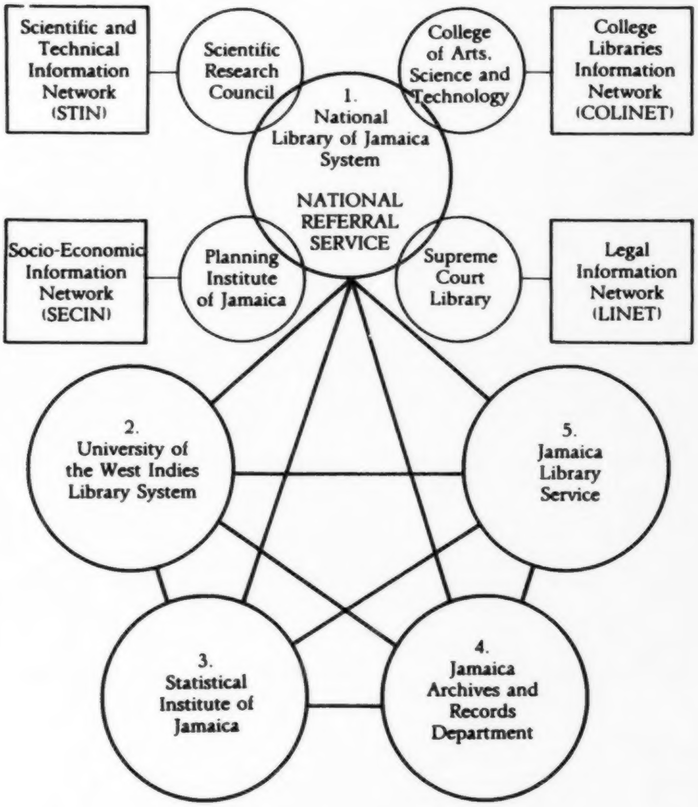

Scientific and Technical Information Network (STIN)
Scientific Research Council
1. National Library of Jamaica System
NATIONAL REFERRAL SERVICE
College of Arts, Science and Technology
College Libraries Information Network (COLINET)
Socio-Economic Information Network (SECIN)
Planning Institute of Jamaica
Supreme Court Library
Legal Information Network (LINET)
2. University of the West Indies Library System
5. Jamaica Library Service
3. Statistical Institute of Jamaica
4. Jamaica Archives and Records Department

Fig. 1. NACOLADS is the national coordinating unit for the information systems in Jamaica and forms an "umbrella" over the five major elements.

not all being served by the network. The focal point for the Jamaica Library Service network is the Jamaica Library Service headquarters.

The UWI's central data-base system can be backed by the comprehensive collections of the UWI's libraries. Because these libraries fall under the jurisdiction of a library committee and form part of a regional university system, the implementation of a data base would seem straightforward. This is not the case, however; a proliferation of faculty and departmental libraries and a variety of constraints have prevented the creation of an effective data base thus far. The focal point for the UWI network is the Main Library of UWI on the Mona Campus.

To date, the main beneficiaries of IDRC funding within the Jamaican information system have been the NLJ, SECIN, and (to a lesser extent) STIN. At the National Library, IDRC funded the posts of two Abstracter/Indexers, one Research Officer, and one Librarian Documentalist. More recently, IDRC funding has facilitated SECIN activities, including surveys of network resources and users, user education, seminars, workshops on indexing and abstracting, and the purchase of equipment.

FROM DISORGANIZATION TO ORDER: SIGNIFICANCE OF THE NACOLADS APPROACH

It is abundantly clear from all the available documentation, from consultants' reports, and from the evidence gathered in this case study that the National Information Plan has had major implications for an integrated approach to information problems in Jamaica and that IDRC has been closely involved from the very beginning in the development of the national plan from concept to operating structure.

Perhaps the most important contribution of the plan was the manner in which it created a structure for discourse and action. One of the important contributions of the working-group approach, for example, was to define classes of resources and the institutions responsible for them. This made it easier to recognize how certain existing structures used resources poorly. The working parties also represented cadres staffed by experts who could be available for advice at any stage in the implementation of the national plan. As a result, continuity and the best use of existing personnel resources were assured throughout the life of the project.

In short, the major benefit of the national plan has been the creation of a system of order where disorder previously reigned. Moreover, the significance of this achievement can best be appreciated when one recognizes that poorer countries have little if any experience in social organization of this sort. In this sense, the creation of a national system in Jamaica could well represent a milestone for other developing nations simply because it provides a mechanism for the better use of scarce human and material resources.

One by-product of any national information system is an improved intellectual climate, frequently evident in the receptivity to new ideas relating to information. This is obvious in the Jamaican context by the acceptance by the business community of information as a commodity that has both benefits and costs. The breakthrough of resistance to automation as being cost effective and necessary is another example. Still another concrete instance of improved attitudes is the announcement by the Director-General of the Planning Institute of Jamaica that there is a crucial need for the wider distribution of technical information and that an effort would be made to meet the demand.

A final consideration of the system's importance lies in its function as a unified voice in arguing for funds. NACOLADS can act as the liaison arm of the National Information Plan in establishing contact with external funding agencies, thereby generating fiscal support for network development. Once funding is assured, the granting and implementing agencies deal directly with each other. In this way, the system's components function with maximum efficiency in each part of the resource acquisition process and excessive "red tape" is avoided. The network participants have been conditioned to common action when dealing with funding agencies at the national level and improved political clout translates directly into better funding and better services.

THE EFFECTS OF JAMAICA'S NATIONAL INFORMATION PLAN IN PRACTICE

Some appreciation of the effects of the national plan, and the difficulties it has had to overcome, result from a closer examination of several major components of the system, the most significant being the NLJ, a centralized resource of unique value upon which the other system components in the national plan can draw.

The Library is the focal point of the National Information System, charged with developing and coordinating an integrated network of libraries in both the public and private sectors. In support of this mission, the national library publishes the Jamaican National Bibliography, maintains a national union catalogue and a union list of serials, and coordinates bibliographic data from the networks involved in the national plan. Through the provision of expertise from its library development service, and of information through its referral service, the NLJ performs two additional important functions that have produced impressive results. Through the acquisition, storage, conservation, preservation, and organization of all materials in whatever format produced, in or about Jamaica, the national library acts as a "collection of last resort" primarily for librarians, scholars, and researchers both in Jamaica and abroad.

Present trends and future developments in library automation will enable the library to increase its efficiency and usefulness to a very great extent. Its central data-base system (one of the three bibliographic data bases proposed in the revision of the national plan) has begun the difficult transition from a manual to an automated system. Although fiscal and technical constraints have prevented rapid expansion of automation activities, the NLJ is now in the process of converting its existing retrospective files into machine-readable form. IDRC has provided training and expertise in the automation of library files and processes and the creation of data bases. Among the national library's projects is the establishment of on-line access to regional and international data bases: a step that will substantially increase its importance as a national central institution.

The Planning Institute's Documentation Centre, which represents the focal point of SECIN, is the second major national network component offering lessons of interest. When a resource survey of information units within the network was completed in 1982, it produced useful information on personnel; budgetary provisions; size, nature, and scope of collections; equipment; and use of classification schemes and cataloguing codes.

The findings of a survey of network users' needs illustrate the scope and complexity of the problems that information systems builders must address in the Third World. The fact that the largest employed occupational groups using the library resources of the SECIN were Management/Administration and Economics/Accounts suggests that the right users are among the service targets. The fact that the largest user group overall is students is rather ambiguous, but is clearly indicative of resource exigency generally. Those who used SECIN's special libraries tended to do so frequently and tended to rely on their entry library to locate materials held elsewhere, emphasizing the potential of the network for resource sharing.

Three findings of the survey shed light on users' needs and the problems that must be solved to meet them. The first finding was the heavy reliance (nearly 90%) of users on the Information Officer to locate information — this indicates a great need for basic education of the users, supported by proper organizational measures in the libraries themselves. The second finding was the frequency of user satisfaction (approaching 70%) — this suggested that users were specific in their information requirements and knowledgeable about the stock of the library; the converse of this measure may be some indication of the degree to which information resources are lacking. The third finding showed that most users rated the information level available to them as above average — this brings out the degree to which users require (and expect) a high degree of subject specialization in SECIN libraries, something that is very demanding in information resources. However, this third finding may also illustrate a well known fact in education and information: if you have no legitimate standard of comparison, it is impossible to measure good, better, and best.

To the extent that generalizations about needs emerge from the survey, the important facts differ little from experience in other nations. Users use what is available to them but need improved collections that cover a broader range of subjects. Current resources, which are timely and up-to-date, are in most demand. The only difference in Jamaica, as in any Third World country, is the extent to which basic requirements that remain must be filled to realize these improvements.

The Planning Institute's Documentation Centre expanded its facilities in 1983, increasing its importance as a focal point as indicated by the number and type of requests with which it dealt. Of 982 requests in 1984, over 50% were for bibliographical references from various sectors of the Institute, and the remainder were for statistical data. A large number of these queries came from outside the Planning Institute system, but a considerable number came from within the Institute itself. The specific point to be noted here is that most of the statistical data required were located at the Statistical Institute of Jamaica. The discrete operations of the Planning and Statistical institutes illustrate the need for computer-sharing facilities to be implemented speedily. What is equally illustrated is the importance of the documentation centre as a resource for researchers, the realization of which was facilitated by IDRC involvement.

Although the foregoing evidence from institutional operations and management is a useful indicator of how a national information plan is proceeding in Jamaica, it is inadequate by itself. In Third World countries, because of the shortage of personnel and management skills, it is almost impossible to create systems that would permit institutional operations to be measured effectively. The irony of this phenomenon is that the absence of such management and control information is exactly the situation that national information plans are designed to remedy. In such cases, where valid statistical measures of implementation effects are absent, the testimony of selected users becomes an important element of the project assessment process.

Joyce Robinson, Chairman of NACOLADS and one of the major architects of the National Information Plan in Jamaica, also notes that even before the plan was developed, the country had an impressive collection of library and documentation institutions: the problem was one of inadequate links. Dr Robinson points out that the decision to give priority to the development of SECIN, influenced by IDRC's interest in funding projects analogous to the Development Sciences Information System (DEVSIS), was vindicated after a change in government in 1980. At that time, the government could have downgraded the implementation of the national plan but, instead, endorsed it, particularly the provision of better socioeconomic information.

Dr Robinson believes IDRC's support has been and continues to be vital to maintaining the momentum of the national plan development process. It is worth noting, she says, that in a period of national financial stringency in Jamaica, one unpropitious for launching new initiatives and securing increased funding, the information services have received some increases in allocation despite the fact that they are not part of any budget earmarked for information. The Government of Jamaica has also fulfilled its undertaking to fund several posts established initially with IDRC support — the national library director and the library development team.

Another perspective on the importance of Jamaica's national information system is provided by Lincoln MacIntosh, deputy director of the Planning Institute of Jamaica. He observes that the Institute's Documentation Centre is one of the major beneficiaries of IDRC support to the national plan. He points out that the Centre is critical to government, researchers, and students because it provides the best economic analysis in the country and publishes the quarterly economic report and the annual economic survey, both of which are relied upon heavily by the business community and the public.

Before IDRC's involvement, the Documentation Centre was able to publish an annual report only, and that lacked the depth of either of the current publications. The improvement in the Centre's operational capacity has occurred because of enlarged and enriched data bases resulting from institutional upgrading.

Mr MacIntosh says the Centre is now seen as a repository and transmitter of information on the government and the Bank of Jamaica. He believes this role is critical because, in a Third World country such as Jamaica, government information operations have more impact than in a developed country. In particular, it is crucially important for planners to realize that, in developing countries, information does not filter as quickly to the private sectors as in developed countries.

Economist Omar Davies of the UWI notes that, before implementation of the national plan under NACOLADS, the Planning Institute's Documentation Centre had no library to speak of — a room 6 m × 6 m — with no professional staff, no organization of materials, and no system. It was, therefore, not a useful resource for students, bureaucrats, or academics. The changes introduced by the implementation of the national plan made it easier to get work done. To begin with, the library is now staffed by a professional librarian, the collection is organized and supervised, and the centre is a comfortable place to work.

Dr Davies regards the Centre as an important source for enhanced teaching and training of researchers, graduate students, and undergraduates. It is also a useful place for outside researchers to come to, and the activities of the Centre have built up the reputation of the Planning Institute so that it is now viewed as a useful and direct arm of the government. Dr Davies also noted how his information-use patterns have altered as a result of the national plan.

> Because of the changes, I now no longer hoard information which might be of use to others; I pass it on to the centre. I perceive others may also be following suit but, as yet, this is not sufficiently widespread in the government service.

Before implementation of the national plan, the Jamaican Trade Union Research Institute had no formal library or trained personnel who it could use as a resource. Even though useful materials were available, they were not accessible. The opening of the Institute's development centre library has helped correct many of these deficiencies and the intervention of NLJ's Library Extension Service was critical to realizing these improvements. This intervention took the form of sending a development team to give assistance, advice, and training. Since the development centre library opened, the development team has continued to assist, particularly with technical services.

Mrs Everett Allen, a research officer with the Institute describes the result of the cooperative efforts of the library extension team and the development centre library staff as the creation of the best library on labour relations and collective bargaining in Jamaica. The library is also open to the public and provides useful general information that is unavailable elsewhere. Despite modest facilities, over 400 users from the general public were recorded in 1984. The development centre library is particularly helpful to the shop stewards, health and safety representatives, and other professionals in the labour movement, and it has the best historical collection on labour matters in Jamaica. Students in business and technical schools, and in high schools, are among other users who benefit.

An insight into the effects of the NLJ's extension service on the private sector was provided by Ingrid Chambers, principal training officer of a major private insurance company in Jamaica. Her company decided about 4 years ago that it needed a central place in which to keep information and, in 1983, they moved to a new head office that allowed space for a library. Shortly thereafter, a special corporate library was established with assistance from the National Library.

"We started from scratch and could not have succeeded without the assistance of the national library's development team," Miss Chambers said. "Now we have a useful, working, special library in operation with part-time professionally trained help." The private library thus created assists decision-makers in producing a more accurate picture of their working environment and is seen by the company as a part of the national network.

Yvonne Brodie, Training Officer with the Jamaica Telephone Company's Media Resources Department, points out that the National Referral Service (established as part of the national plan) has resulted in considerable improvement in coordinating services. Before the service was instituted, effective cooperation among information institutions was practically impossible, but as Miss Brodie remarks

> we must have increased access to scientific, educational, social science, and economic data if we are to remain part of the modern world. It is only through the development of effective network links among institutional nodes staffed with qualified professionals that we can have any chance of success.

Stephaney Ferguson, Director of the NLJ, says that the information systems in use show how effective the national plan has been. For example, the national referral service handled 500 requests in 1984, providing important linkages between and among government and industry libraries. Similarly, the Library Extension Services Department assisted 64 libraries in the past 4 years. This means that information infrastructure is in fact being improved and, as Miss Ferguson points out, this activity has important cumulative effects on information availability in general.

In the university community, effective application of automation is vitally necessary if the capacity for intellectual investigation is to keep pace with global standards. Librarian Albertina Jefferson, of the Mona Campus, observes that one of the major problems that Jamaica has faced in developing effective information systems is in exploiting the potential of automation and computerization.

The implementation of the national plan, however, has provided a structural environment within which effective development of automated systems can proceed. Equally important has been the provision of consultancies and advice concerning automation planning and training opportunities for personnel responsible for systems development.

Although the testimony of information professionals in Jamaica emphasizes the diversity of the environment and the variety of the problems, one recurring argument emerges: it will take time, perhaps as long as a generation, for the system to have any real impact. This will first be felt by information elites (professionals, managers, and scientists), then by the subsidiary constellation of paraprofessionals, assistants, and technicians, and finally by the general public.

The implementation of the national information plan in Jamaica represents that essential first step toward creating the set of information systems that the nation must have. In many ways, this process is analogous to the conservation of cropland through the slow, patient, nearly invisible development of a nourishing network creating the foundation for further growth.

THE NATIONAL INFORMATION PLAN: ACCOMPLISHMENTS AND PROSPECTS

In assessing IDRC's involvement with the information system resulting from the NACOLADS plan, every Jamaican interviewed agreed that, from the beginning, financial and technical assistance from IDRC was a major factor in the realization of plans for personnel and other components of the national information system. There were, in addition, equally important although less readily quantifiable benefits. IDRC provided momentum during a period of severe economic decline, served as a catalyst during the process of implementation, and provided a significant international dimension for the project.

Much of the effectiveness of the national plan discussed here results directly from its concentration on practical goals that were significant as well as realizable. The establishment of the NLJ was an essential and logical first step. The establishment of NACOLADS was concrete recognition of the role of library and information systems in Jamaica's national development.

Maximization of effective resource use has been a keynote of NACOLADS' planning from the very beginning. This has provided for the introduction of modern technology, where appropriate, in a phased, orderly process. It has also resulted in establishment of national standards and provision of support for professional education. Clearly, progress in the development of a modern integrated information system in Jamaica has been substantial.

Firm leadership, sustained program planning and development, and dedicated professionals have enabled the system to overcome many problems. NACOLADS has acted as an effective intermediary between the Jamaican information community and prospective donors, acquainting them with the severity of the problems encountered in improving Jamaican information systems. The response of agencies such as IDRC, within the context of their own general program support, has been instrumental in the evolution of a greatly expanded and improved network with a plethora of new services.

CHAPTER ELEVEN

CROPPING SYSTEMS RESEARCH IN INDONESIA*

Between 1974 and 1980, IDRC provided CAD 516 000 to the Indonesian Central Research Institute for Food Crops (CRIFC) through the International Rice Research Institute (IRRI). The aim was to augment efforts already started in Indonesia to develop cropping systems for rainfed and partially irrigated rice areas. By carrying out the research on a cooperative basis with farmers on their fields, it would be possible to establish which systems were the most practical, productive, acceptable, and profitable. IDRC's contribution was largely devoted to staff costs, research expenses, travel, and training. This chapter describes the research and the effects that have been felt in those areas where the improved systems were tested. It should be noted that the study does not attempt to attribute how much of the increased production and income is due to the various factors and agencies — few studies are able to do this. IDRC and the United States Agency for International Development provided the initial support for the work done by CRIFC, and IRRI provided training and advisory personnel. Subsequently, the World Bank, the Food and Agriculture Organization of the United Nations, the United Nations Development Programme and the governments of Japan and the Federal Republic of Germany contributed. These external contributions, however, come to nought without the efforts of the Indonesian scientists, extension workers, and, above all, farmers.

**This chapter is based on a report by B.H. Siwi, Inu G. Ismail, Imtias Basa, A. Syarifuddin, M. Sultoni Arifin, Aman Djauhari, Mahyuddin Syam, Paul Mundy, and Jerry L. McIntosh (Siwi et al. 1985) of the Central Research Institute for Food Crops, Bogor, West Java.*

INTRODUCTION

Indonesia was the world's largest importer of rice for several years before reaching self-sufficiency in this staple in 1982. By 1984, rice output had risen to 25.8×10^6 t of milled grain and Indonesia was able not only to feed its 160 million people but also to seek export markets. The production of other food crops also increased markedly, although there have been fluctuations caused mainly by adverse weather. The national output of maize, for instance, more than doubled from 2.29×10^6 t in 1969 to 5.36×10^6 t in 1984; soybean production rose from 0.39 to 0.52×10^6 t, peanuts from 0.27 to 0.74×10^6 t, mungbean from 0.04 to 0.19×10^6 t, and cassava from 10.92 to 14.21×10^6 t in the same period.

Among the many factors that have contributed to this remarkable achievement are progressive government policies, effective extension, and, most importantly, willingness of farmers to adopt improved technology spawned by agricultural research.

Cropping systems research, in particular, has shown that two or more crops can be grown in rainfed wetland areas where there is partial or full irrigation and that better crop management can double the productivity of dryland areas.

Indramayu in West Java and Central Lampung in southern Sumatra (Fig. 1) were the first areas in Indonesia, selected in 1975, for cropping systems research supported by IDRC and conducted by the Central Research Institute for Food Crops (CRIFC).

Indramayu lies on the north coast of West Java, about 200 km east of Jakarta. The land is flat, about 20 m above sea level, and is typical of many wetland rice areas in Indonesia, with a pronounced dry season followed by 6 months with over 200 mm of rain per month. Indramayu can be divided into four categories of land based on the number of months per year when irrigation water is available:

- I — irrigation water for 10 months,
- II — irrigation water for 7 months,
- III — irrigation water for 5 months, and
- IV — rainfed (nonirrigated) wetland.

In category I and II areas, most farmers planted two crops of 'Pelita I-1', a high-yielding rice variety that matures late — in about 140 days. In category III and IV areas, most farmers grew only one rice crop per year.

In Central Lampung, the scientists selected a partially irrigated rice-producing wetland area similar in many respects to category III in Indramayu. The research site chosen in this target area was in the village of Nambahdadi. Although the soil here was less fertile than in Indramayu, the rainfall exceeded 200 mm/month for at least 9 months of the year. Farmers in Nambahdadi grew only one rice crop each year, even though their neighbours in dryland areas nearby grew food crops year-round.

The scientists also chose a dryland target area in Central Lampung. The research site included the villages of Bandar Agung and Komering

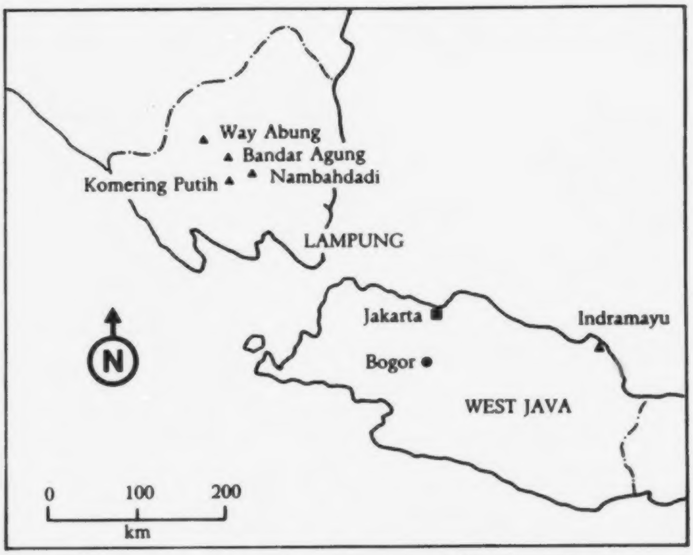


Fig. 1. Locations of cropping systems research sites in Indonesia.

Putih where farmers traditionally planted maize, dryland rice, and cassava together at the beginning of the rainy season. Most of the rainfed dryland areas of Lampung have red-yellow podsolic soils that had previously been thought unsuitable for growing food crops because they are acidic, infertile, very porous, and easily eroded. The cropping systems research has shown, however, that, with moderate amounts of fertilizer and judicious soil and crop management, these soils have considerable potential for food production. This is true not only of Central Lampung but also of other areas such as North Lampung and South Sumatra.

Later, the research and development effort was extended to other areas, including North Lampung, Aceh, and West Nusa Tenggara, with the support of various agencies.

THE NEW CROPPING PATTERNS AND THEIR EFFECTS

INDRAMAYU

When the research in Indramayu began, the most common cropping pattern used by farmers in the fully irrigated areas was a double cropping of 'Pelita' rice. Farmers would plant the first crop at the beginning of the rainy season, and the second toward its end. In the partially irrigated areas, however, where water was not available long enough to allow the grain of the second rice crop to fill properly, yields were often low or lacking altogether, leading many farmers to plant only one rice crop each year (Fig. 2).

After 3 years of testing, the researchers developed promising cropping patterns for land in each irrigation category. They found various

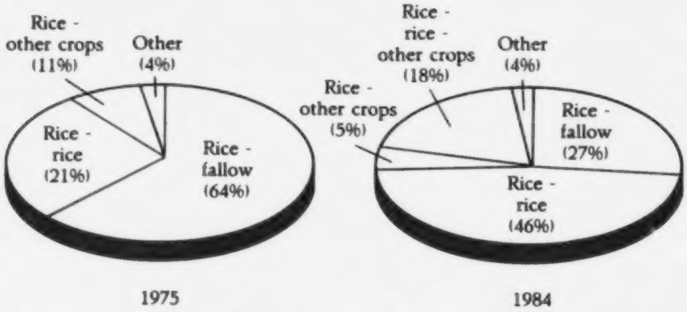


Fig. 2. Cropping pattern changes in partially irrigated areas in Indramayu, West Java, 1975–84.

ways of planting and harvesting each rice crop earlier, thereby minimizing the risks arising from water shortages during the second crop. Three of these methods were the *gogorancah* and *walik jerami* management techniques and the planting of rice varieties that matured earlier (in 120 instead of 140 days) such as 'IR26' and 'IR28'.

Gogorancah means that instead of waiting for the rains before they transplant their rice seedlings, farmers plant rice seeds directly into the unpuddled soil and allow the plants to grow before enough water is available to flood the fields. Using this technique for the first rice crop can save up to 1 month compared with traditional transplanted rice.

The time between the harvest of one crop and the planting of the next can be shortened by *walik jerami* — minimizing the tillage for the second crop. With *walik jerami*, the farmers cut the stubble of the first rice down to ground level, and then spread it on the field. They then plant the seedlings for the second rice crop without tilling the soil. Compared with the traditional method of full tillage, *walik jerami* can reduce the time between crops by as much as 7–15 days.

Although the *gogorancah* and *walik jerami* techniques had already been used by farmers in Indonesia, the researchers adapted and refined them to suit the needs of the target areas, and encouraged local farmers to adopt them when conditions were favourable.

Shortening the period needed for the two rice crops meant that there was still enough soil moisture left to plant a third crop after the second rice harvest. This additional crop could be a drought-tolerant legume and the researchers found at least three that farmers could choose from — soybean, mungbean, or cowpea. Of these, mungbean requires the least time to mature (60–65 days compared with 80–90 days for soybean and cowpea), but cowpea is the most drought tolerant.

The researchers also introduced other improved management techniques, including early maturing varieties, adequate fertilizer dosages and application methods, and pest and disease control techniques.

The new technology increased crop yields and farmers' incomes (Table 1) in the category III areas of Indramayu (where irrigation water

Table 1. Comparison of yields and net return of traditional and introduced cropping patterns[a] in a partially irrigated area in Indramayu, West Java, 1976/77 and 1983/84.

	1976/77		1983/84	
	Traditional	Introduced	Traditional	Introduced
1st crop rice (t/ha)	3.6	4.8	3.6	4.9
2nd crop rice (t/ha)	2.3	4.6	2.9	4.7
Mungbean (t/ha)	–	0.5	–	0.8
Net return ('000 IDR)[b]	358.0	477.0	376.5	598.5

Source: Siwi et al. (1985).

[a] Traditional farmers' pattern = wetland rice–wetland rice; introduced pattern = *gogorancah* rice–*walik jerami* rice–mungbean.

[b] Based on 1985 prices: 1000 Indonesian rupiahs (IDR) = 1.24 Canadian dollars (CAD).

is available for 5 months of the year). In 1976/77, the introduced three-crop pattern gave higher yields and profits than the traditional double cropping of rice. The two rice crops in the improved pattern yielded a total of 9.4 t/ha, 3.5 t/ha more than the traditional pattern. Farmers who used the improved pattern doubled the yield from their second rice crop, from 2.3 to 4.6 t/ha, because of smaller losses due to drought. Together with 0.5 t/ha of mungbean, this meant that the profits of farmers who used the pattern developed by the researchers were 33% higher.

By 1983/84, the introduced pattern was even more profitable. Farmers still planting just two rice crops without using the improved methods reaped a profit of only IDR 376 000/ha compared with nearly IDR 600 000 ha for the introduced pattern (in 1985, 1000 Indonesian rupiahs [IDR] = 1.24 Canadian dollars [CAD]).

The results of improved techniques tested over a wider area since 1978 and involving more farmer cooperators and extension workers have been encouraging and have spread to neighbouring areas through production programs and extension services.

Farmers in the target area, where the average land holding is 0.4 ha, have gradually intensified their cropping patterns with the help of new, earlier maturing rice varieties and recent improvements to local irrigation facilities by the Public Works Department. In 1975, before the cropping systems research had produced results, only 21% of the partially irrigated area — 7300 ha — was planted to two crops of rice each year, and no land was triple-cropped (Fig. 2). By 1984, 46% of the area — 16 000 ha — was double-cropped and an additional 18% — 6300 ha — was planted to three crops (rice–rice–nonrice). The area planted to only a single rice crop fell from 64% to only 27%.

These changes have resulted in more land being cropped in the dry season. Between 1975 and 1983, the total area of rice harvested rose from 183 000 ha to 195 000, an increase that can be attributed to a larger area for the second (dry season) rice crop, which rose from 66 000 ha in 1975 to 79 000 ha in 1983. The slightly larger area cropped and the much increased yields obtained meant that total rice production in 1985 was double that of 1975 (Fig. 3).

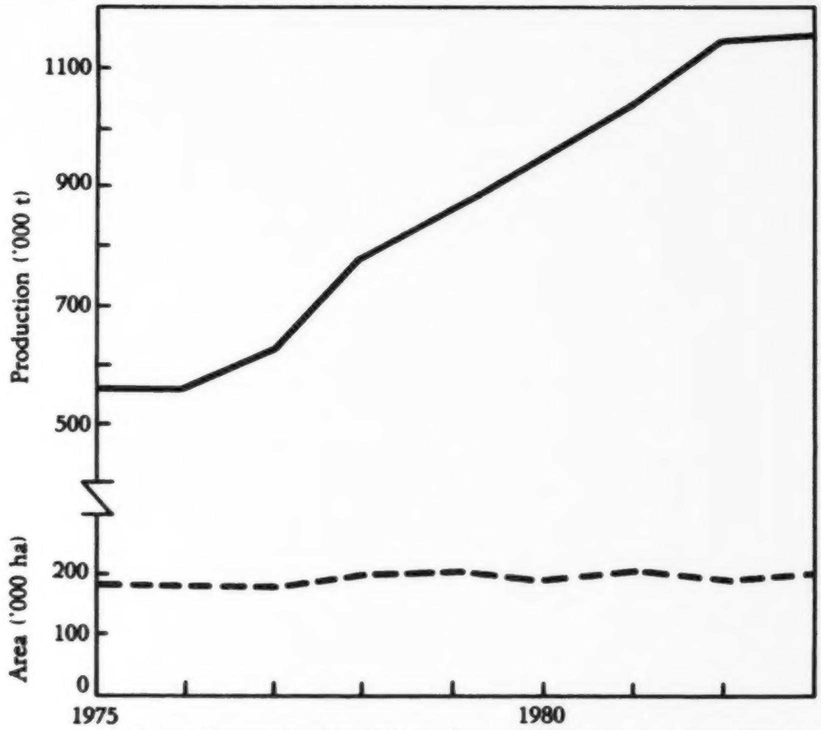


Fig. 3. Area harvested and production of rice in Indramayu, West Java, 1975–83.

The area planted using the *gogorancah* system has fluctuated around 5000–10 000 ha, with variations between years caused by the weather. *Gogorancah* is ideal when irrigation water is not available and the wet season is slow to start because it allows farmers to plant their rice without having to wait for enough rain to flood the fields. If the rainy season comes early, however, or if irrigation water is available, it is better to grow normal, transplanted rice.

There are two main problems with the *gogorancah* approach: it is difficult to prepare the soil when it is still dry, and weed control may be difficult. In Indramayu, recent improvements in irrigation facilities mean that water is now available for longer each year. With earlier maturing varieties of rice, and the shorter replanting time between the crops made possible by *walik jerami* or the use of tractors, many farmers no longer have to rely on *gogorancah* to fit in two rice crops.

The adoption rate of legumes as the third crop has been rather slow. The area devoted to peanuts and soybeans decreased somewhat between 1975 and 1983, whereas that devoted to mungbeans rose. Preferring low risks, farmers tend to grow mungbeans because they need less seed, are easy to grow, mature early, are less susceptible to pests, and have a stable price. The farmers' choice of rice varieties may also influence the area of legumes planted: they often grow the rice variety 'Cisadane', even though it takes about 25 more days to mature, because of its better taste and price compared with 'IR36' or 'IR38'. If they double-crop this variety, not much time is left to grow a third, legume, crop.

LAMPUNG

Partially Irrigated Area

The first attempts to improve cropping patterns in the partially irrigated area of Lampung consisted of introducing earlier maturing rice varieties, reducing replanting time for the second rice crop, and growing nonrice crops during the dry season. Research during the years 1975–1977 showed that two crops of rice followed by a legume (cowpea) performed well in this area. This was confirmed by a preproduction trial covering 2.5 ha in 1977/78 (Table 2). In this trial, the farmers' traditional pattern of one rice crop yielded 3.7 t/ha. The introduced cropping pattern produced 8.5 t/ha of rice from two crops as well as 0.7 t/ha from a third crop — cowpea. In 1983/84, farmers who had adopted the new pattern and methods harvested more than twice as much as those who used the traditional pattern — equally, their net income was also more than double.

These research findings, spread through the extension services and coupled with improvements in local infrastructure, have brought about major changes in the cropping patterns used in Central Lampung, where the average land holding is 1.2 ha. In 1975, before the implementation of cropping systems research in this area, only 27% of farmers grew two rice crops per year, using traditional techniques (Fig. 4). A study in 1982 found that 41% of the farmers — about 25 000 — now planted two rice crops on 30 000 ha: a *gogorancah* crop followed by a transplanted crop with minimum tillage. Another 30% — 19 000 — planted three crops on 23 000 ha: *gogorancah*, transplanted rice, and a nonrice crop. The proportion of farmers growing only a single rice crop each year fell from over 30% to only 4%.

According to the district agricultural service, 45 000 ha of land were cultivated to two rice crops in 1982 — including both double cropping of rice and triple cropping, where the third crop is not rice.

Table 2. Comparison of yields and net return of traditional and introduced cropping patterns[a] in a partially irrigated area, Lampung, Sumatra, 1976/77 and 1983/84.

	1976/77		1983/84	
	Traditional	Introduced	Traditional	Introduced
1st crop rice (t/ha)	3.7	5.6	3.9	3.6
2nd crop rice (t/ha)	–	2.9	–	3.5
Cowpea (t/ha)	–	0.7	–	0.7
Net return ('000 IDR)[b]	204.0	609.0	231.2	518.5

Source: Siwi et al. (1985).

[a] Traditional pattern = single crop of wetland rice; introduced pattern = *gogorancah* rice–wetland rice–cowpea.

[b] Based on 1985 prices: 1000 Indonesian rupiahs (IDR) = 1.24 Canadian dollars (CAD).

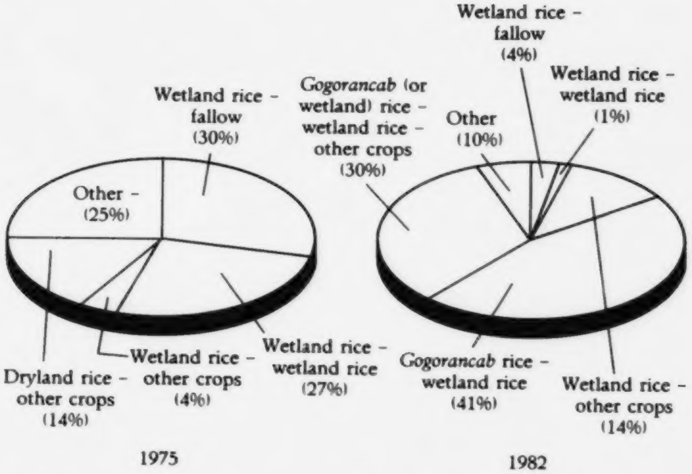


Fig. 4. Cropping pattern changes in partially irrigated areas, Central Lampung, 1973–82.

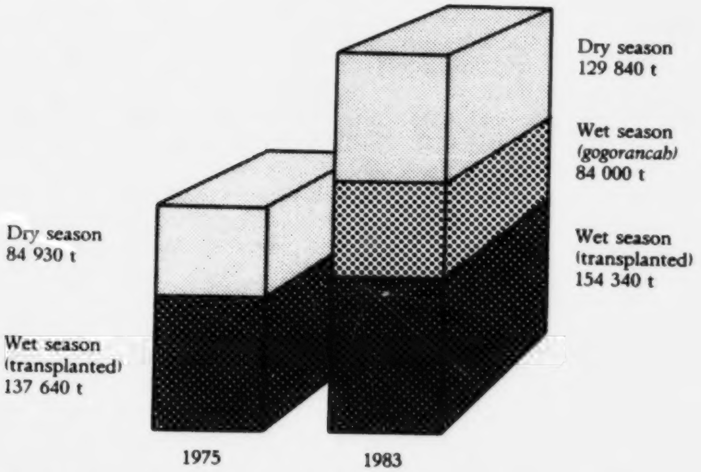


Fig. 5. Rice production in partially irrigated areas, Central Lampung, 1975 and 1983.

As a consequence of this intensification, the production of rice in Central Lampung increased from 222 600 t in 1975 to 378 200 in 1983 (Fig. 5). Farmers who fully adopted the new cropping system obtained higher total yields from all three crops (Table 3) and earned net returns more than three times higher than those of farmers who continued the traditional practices (Table 4).

Table 3. Multiple cropping index[a] and crop yields obtained by farmers who adopted or did not adopt improved cropping patterns, Way Seputih Irrigation Scheme, Lampung, 1981/82.

Farmer's extent of adopting new pattern	Multiple cropping index[a]	Crop yield (t/ha) First rice	Second rice	Cowpea
Fully	251	3.3	3.9	0.7
Partially[b]	189	3.3	3.5	–
None	162	3.9	–	–

Source: Djauhari and Krisnaningsih (1983).

[a] The multiple cropping index measures how intensively the land is cropped throughout the year — the higher the index, the more intensive the cropping pattern.

[b] These farmers planted two rice crops per year using the *gogorancah* technique for the first crop, but did not plant a third, nonrice, crop.

Table 4. Average costs and returns ('000 IDR)[a] of farmers who adopted or did not adopt improved cropping patterns, Way Seputih Irrigation Scheme, Lampung, 1981/82.

Farmer's extent of adopting new pattern	Gross return	Cost of labour	Cost of materials	Net return
Fully	977.1	347.1	105.1	524.9
Partially[b]	791.7	303.0	97.9	390.8
None	360.8	156.0	39.6	165.2

Source: Djauhari and Krisnaningsih (1983).

[a] Based on 1985 prices: 1000 Indonesian rupiahs (IDR) = 1.24 Canadian dollars (CAD).

[b] These farmers planted two rice crops per year using the *gogorancah* technique for the first crop, but did not plant a third, nonrice, crop.

Many farmers who adopted the improved methods were influenced by the success of their neighbours who cooperated with the research team in testing the new patterns. This may be seen from the experience in the project village of Nambahdadi in Central Lampung. Starting with only a 0.1-ha demonstration plot in 1976/77, the area featuring the *gogorancah* system spread to 640 ha in Nambahdadi and 5500 ha in the Way Seputih irrigation scheme in 1981/82. Adoption of the *gogorancah* technique reached a peak in 1982/83, with a total of 72 000 ha in the province of Lampung.

In the partially irrigated areas in Central Lampung, there are no plans to improve the irrigation supply, as has happened in Indramayu. This means that growing the first rice crop using the *gogorancah* method is still a useful way of planting two crops of rice per year. However, the lack of seeds and the small size of the local market may still discourage many farmers from planting legumes as a third crop in the new pattern.

Dryland Areas

Once the production potential of the dryland areas of Lampung had been shown, the scientists developed various cropping patterns and improved soil- and crop-management practices that enabled these soils to be used year round. One of the systems that they tested features five dryland crops — maize, dryland rice, cassava, peanut, and either ricebean or cowpea — grown in a rotation, with intercropping that ensured the soil surface was continuously covered by vegetation to prevent erosion. This five-crop-per-year system produced two to four times more food calories than the farmers' traditional pattern. Over a 5-year test period at Banjarjaya in Central Lampung, for instance, it produced food-calories equivalent to as much as 18.4 t/ha of rough rice per year, compared with 4.8 t under the traditional pattern (Table 5 shows results for 1 year).

Application of the research findings in the dryland areas in Lampung has had a considerable impact on both regional and national crop production. In 1975, 103 700 ha of dryland rice and 28 600 ha of corn were harvested in Lampung. In 1984, the rice crop covered 150 200 ha and corn, 97 000 ha.

The impact on total output was even more marked: the production of rice in 1984 was more than double that of 1975, whereas maize production had more than tripled. The output of other dryland crops also rose significantly. Cassava production, for instance, increased from 644 700 t in 1977 to 1 469 000 t in 1984; peanut output rose from 4900 to 13 700 t; and soybean from 35 100 to 40 000 t over the same period.

Table 5. Comparison of yields, net return, and rice equivalent of traditional and introduced cropping patterns[a] in dryland areas in Lampung, 1976/77.

	Central Lampung		North Lampung	
	Traditional	Introduced	Traditional	Introduced
Maize (t/ha)	0.8	2.0	0.9	2.6
Dryland rice (t/ha)	2.0	1.7	1.9	3.7
Cassava (t/ha)	–	21.1	9.8	19.9
Peanut (t/ha)	0.8	1.7	–	0.6
Ricebean (t/ha)	–	0.3	–	0.3
Net return ('000 IDR)[b]	110.9	216.6	125.8	409.7
Equivalent yield of unhusked rice (t/ha)	4.3	18.2	8.2	18.9

Source: Siwi et al. 1985.

[a] Traditional pattern = maize + dryland rice followed by peanut (Central Lampung) or maize + dryland rice + cassava (North Lampung); introduced pattern = maize + dryland rice + cassava, relay cropped with peanut, followed by ricebean.

[b] Based on 1985 prices: 1000 Indonesian rupiahs (IDR) = 1.24 Canadian dollars (CAD).

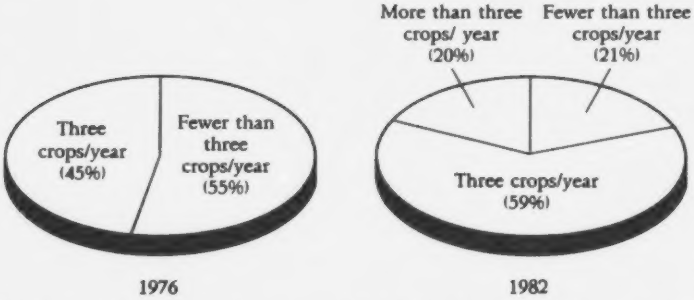


Fig. 6. Cropping pattern changes in rainfed dryland areas, Way Abung, North Lampung, 1976–1982.

A study of Way Abung, in North Lampung, in 1982 showed that substantial changes had taken place in local farming. In 1976, before the implementation of cropping systems research, 55% of the dryland area in Way Abung was planted to two or even a single crop per year. In 1982, 59% of the area was planted to three crops and 20% of the area to more than three crops per year (Fig. 6). This technology has spread throughout the major dryland rice-producing areas in Indonesia.

IMPACT OF CROPPING SYSTEMS RESEARCH AT THE NATIONAL LEVEL

At the national level, cropping systems research has had an impressive effect not only on crop output, but also on government policy and agricultural research and production programs.

The study of cropping systems in Indonesia began in 1970 under the auspices of CRIFC of the Ministry of Agriculture. The aim of the research — initially conducted at experimental stations — was to find ways to grow crops on poor or underutilized land and to develop more intensive and productive cropping patterns. The scientists soon realized that if they conducted their tests in farmers' fields, they could get more useful information and rapid feedback. In 1973, they began systematic research to intensify crop production in Indramayu (West Java) and to improve and stabilize crop production in dryland areas in Lampung (southern Sumatra). In 1975, IDRC provided support through the International Rice Research Institute (IRRI) to expand this research into farmers' fields over a wider area. In 1976, the Indonesian Directorate General for Transmigration gave funds to extend the studies to several areas being settled by "transmigrants" from Java. Since then, with support from other agencies, cropping systems research, coordinated by CRIFC, has been carried out in about 40 different areas throughout the country. The research program in each area depends on the local conditions and needs, and the program changes over time as these alter.

In 1980, the national *bimas* (mass guidance) intensification program formulated recommendations for cropping systems for different land types. These recommendations covered land irrigation for 5 and 7 months, rainfed land, tidal swamps, and dryland areas. The *bimas* program now provides farmers with credit and inputs for year-round cropping patterns in dryland and rainfed wetland areas. Experience has shown that crop production programs that provide credit and inputs are vital if large numbers of farmers are to adopt the improved techniques.

From 1980 to 1982, the government carried out a number of *opsus* (special operations) to intensify crop production in certain areas. Among these *opsus* were

- *Tekad Makmur* to implement the *gogorancah* followed by a nonrice crop pattern in West Nusa Tenggara — this operation changed the province from a food importer into an exporter;
- *Merah Megapah* to implement the *gogorancah*–wetland rice–nonrice pattern in Lampung;
- *Subur Makmur* to implement the *gogorancah*–nonrice pattern in West Java; and

- *Gemah Ripah* to implement the dryland cropping pattern — this changed the Gunung Kidul area of Central Java–Yogyakarta from a food-deficient into a self-sufficient area.

Several other regional programs have been based on the results of cropping systems research. The soybean area in Aceh Province, for instance, increased from less than 10 000 ha in 1981 to more than 50 000 ha in 1985, mainly because many farmers now grow soybean after harvesting their wetland rice. The same thing has happened, perhaps to a lesser extent, in Jatiluhur (West Java) and in Central Java, East Java, South Sulawesi, and West Nusa Tenggara.

The success of these production programs has shown that a cropping system developed in one area can be successfully transferred with only minor modifications to another with similar soils and climate. "Fine tuning" of the cropping system will, of course, be necessary to cope with variations in local conditions. The ideal cropping system will also change as local infrastructure develops, new markets emerge, or prices alter.

In terms of national agricultural production, double cropping of rice in Indonesia has increased markedly over the last 7 years, so have yields of the second crop in areas where the research results have been applied. Higher production of other food crops has also been made possible on a national scale through more intensive cropping systems and improved agricultural practices. This progress has, in turn, improved farmers' incomes and reduced national expenditures on imports of rice and other crops.

IMPACT ON RESEARCH

In terms of research, scientists in Indonesia have accepted the systems approach as the most appropriate way to increase crop production and farmers' welfare, but at the same time respecting the environment. This research approach has now been broadened to encompass the whole farm system, including food and nonfood crops, animals and fisheries, the farm environment, and the farm-family's nonfarm activities. Researchers are now seeking ways to use perennial crops such as rubber, fruit, and coconuts to provide the farmer with more cash for little extra work, while animals such as goats or cattle can provide meat, be sold for extra income, or be used for plowing.

Scientists are now using on-farm research techniques based on the cropping systems approach to solve problems related to several land types in Indonesia, including upper river watersheds and tidal swamps. The Agency for Agricultural Research and Development of the Ministry of Agriculture has formed an interdisciplinary farming systems group to do this work.

The direction and aims of commodity- and discipline-oriented agricultural research have shifted as a result of the cropping systems experience. Scientists working in these areas can now view problems better from the point of view of the complete cropping system, rather than in isolation. This is true in the case of varietal improvement and in studies of fertilizer efficiency, aluminum toxicity, and shade tolerance.

The cropping systems program has also strengthened the links among the organizations involved in agricultural development, such as research, extension, transmigration, public works, communication, and administration, and among politicians and decision-makers.

TECHNOLOGY DEVELOPMENT AND DISSEMINATION

The cropping systems research consisted of five distinct phases, from the selection and study of the target area and research site, through the design and testing of the cropping patterns, to the transfer of the new technology to the farmers.

First, a preliminary study was made of land, water, and agroeconomic conditions in the target area to enable the scientists to choose a site for their on-farm research. The target areas — where farmers could apply research findings to improve their farming methods — were selected on the basis of four major criteria

- Critical food shortages and governmental designation;
- Existence of large expanses with similar soils and climate;
- Previous experience had shown that intensifying cropping patterns was feasible; and
- Existence of markets and infrastructure.

Second, economic and biological factors influencing the local farming system were studied in detail at the research site. Examples of such studies are tests of high-yielding crop varieties grown under local conditions, experiments to determine the ideal fertilizer dosages needed for each crop, the development of guidelines for pest and disease control, and studies of the economic profitability of various crops and management levels.

Third, using the results of these component studies, the researchers designed and tested various cropping systems. They compared the traditional cropping pattern used by local farmers with a number of new patterns requiring different labour and cash inputs. Groups of farmers cooperated with the researchers in testing these cropping patterns in their own fields.

Fourth, when the most promising of these patterns had been determined, it was implemented on a larger area of land to make sure that it was "visible" to local farmers and extension workers. This preproduction testing was also used to further evaluate the new technology, and to find any weaknesses in the improved pattern or in the local infrastructure.

Fifth, the final phase of the process was the dissemination of the improved system to farmers by extension services and the local and national governments through demonstration plots, recommendations, and training, supported by the provision of credit and subsidized inputs through crop production programs. By these means, the new cropping systems have spread throughout the original target areas, and to other regions of Indonesia with similar soils and climate.

Anticipating the important role that various agencies and key personnel would have to play in implementing the new technology, the cropping systems working group solicited their participation and support at an early stage to ensure the success of the project. Indeed, the involvement of local government officials from the first phase onward proved to be very useful in identifying problems and explaining the consequences of the technology to farmers in the region.

Most of the responsibility and the work load in the preliminary phases of the research fell on the cropping systems researchers. The involvement of the farmers usually started in the second phase, when economic and biological components were studied, and increased in the third, when the cropping patterns were designed and tested. In the fourth and fifth phases, during the preproduction testing and implementation activities, most of the work load fell on the farmers, on extension personnel, and on local and national government staff.

Several methods were used to inform all those involved in the program — researchers, farmers, extension workers, and government officials — of the progress made and the results achieved. Such communication is important, not only to transfer the research findings to those who need them but also to maintain and improve cooperation among those involved in the research itself. Regular meetings, scientific workshops, and field days were held; personnel were given special training; and a number of publications were produced. Informal contacts, however, were most useful and, at the research site, they worked smoothly because farmers, researchers, and extension workers all saw the need to work together.

Various meetings, including regular scientific workshops and seminars, were held not only to report on the progress made in the research, but also to give members of the cropping systems working group and personnel from different agencies the opportunity to improve their understanding and thus work closer together.

Field days to inform farmers of the new technology could be held in several locations because key personnel from the local government and extension services were closely involved in the program. During these sessions, various aspects of the new technology were discussed, such as the research methods used and the introduction and implications of the improved cropping systems. Field days could be held during the verification trials, but were more appropriate during the preproduction or pilot-production phase when the other government agencies were actively involved in the field work.

Over the past decade, the Indonesian cropping systems program has developed skilled personnel through formal training, both in Indonesia and abroad. Courses provided to research staff and extension subject-matter specialists by CRIFC and IRRI have been very effective in broadening the trainees' perception of cropping systems research and development. The courses have also contributed to good working relationships and closer cooperation between researchers and extension workers — an important aspect of technology transfer.

Special training courses held for field extension workers at the cropping systems reseach sites improved the workers' knowledge of the new technology and their ability to instruct farmers in its use.

Most of the publications on cropping systems have appeared in the form of symposium proceedings and have been both an important means of communication among scientists and an invaluable source of information to others interested in research and development.

LESSONS

The cropping systems experience in Indonesia has taught us a number of things. First, it has underlined the importance of on-farm research in developing new cropping techniques that farmers can and will accept. Experimental farms run by research institutes may provide "ideal" conditions under which various components of a new set of farming methods can be developed and tested, but only research in farmers' fields can demonstrate the effectiveness of new methods, show their weaknesses, and point out what problems remain to be solved.

A second lesson is the importance of involving farmers, extension workers, and government officials from the start of the research and development process. They provide valuable insights into problems and possible solutions at the research stage, and their cooperation is essential later if the research results are to reach a large number of farmers over a wide area.

Third, the Indonesian cropping systems program has shown the importance of government production programs in encouraging large numbers of farmers to accept the new techniques. These production programs combine extension and training for farmers with the provision of credits and subsidized inputs to enable them to take advantage of the improved cropping systems.

Finally, experience has demonstrated that the cropping patterns tested in the original target areas can be transferred widely to other areas with similar climate, soils, and socioeconomic conditions and can be modified to suit local conditions. This means that the original investment made in cropping systems research has paid off by raising farmers' living standards and increasing food production throughout the country.

CONCLUSION

The potential for expanding Indonesia's agricultural output is large. Of the country's total land area of 192 × 10^6 ha, only 16 × 10^6 ha are being used for the production of food crops. It is estimated that 3 × 10^6 ha of wet- and dryland could be brought under cultivation by the year 2000. Moreover, the number of crops grown each year on land already in use could be increased significantly. More than 50% of the wetland area is still planted to only one rice crop per year. In the dryland areas, most farmers grow only corn, dryland rice, and cassava in mixed cropping patterns during the rainy season, but do not make efficient use of soil water and rainfall during the drier times of the year.

Cropping systems research has made major contributions to agricultural development in Indonesia's partially irrigated and rainfed dryland areas. This research has found ways of using underutilized lands and of cropping existing agricultural land more intensively and productively. In the partially irrigated areas in both Indramayu and Lampung, research has shown that double cropping of rice is feasible by introducing the *gogorancah* (direct seeding) system, reducing replanting time, planting early maturing rice varieties, and improving crop management. In the rainfed dryland areas, the research has shown that, if they are managed properly, soils previously thought unsuitable for permanent cultivation of annual food crops can be cropped continuously without loss of fertility. In these areas, intensive cropping systems involving five or more crops per year enable farmers to be self-sufficient in food crops and can guarantee them a reasonable livelihood. In the long run, a more stable and sustainable agriculture will depend on a mixed farming system involving animals and perennial crops as well as food crops. The principles and concepts developed during the cropping systems work can be used to integrate the animal and perennial crops into the farming systems approach.

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CHAPTER TWELVE

FUELWOOD AND POLEWOOD IN MALAWI*

In September 1978, just before the rainy season, staff of the Department of Forestry and the Forestry Research Institute of Malawi began a project titled *Fuelwood Plantations*. Supported by IDRC, whose contribution was CAD 203 000, the project aimed to find out which species of trees were most suitable for the drier and most heavily populated parts of the country. Over the next 3 years, a total of 93 trial plots was established at 73 sites in seven silvicultural zones. Only five of the sites were in forest reserves; on the remaining 68, the people owning and using the land had to be persuaded to become involved in the experiment and to volunteer some land for the trial plots. It was made clear that the land and the trees growing on it would revert to the owners at the end of the project. This project is remarkable for two main reasons: one, because it is an example of participatory research that was effective both as research and as demonstration of improved technology and, two, because tangible benefits began to be realized after as little as 5 years — rare enough in any research, and more so in forestry. Also, in the context of a committed government and an orderly institutional framework, the project leader, R. Nkaonja, was able to exercise his talents as a researcher and a motivator. Conducting research in the field is one thing; persuading people to conduct research with some of their own resources is quite another.

INTRODUCTION

With a total land area of 94 276 km^2 and an estimated population of 6.8 million, Malawi has one of the highest population densities in Africa

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This chapter is based on a report prepared by L.A.H. Msukwa, Director, Centre for Social Research, Zomba, Malawi, and R.A. Nickerson, a forestry consultant.

— 72 persons/km^2. The population is not evenly distributed, however, and higher densities in the south and some districts in the Central Region have led to overutilization of the land base and rapid disappearance of the natural tree cover that has been the source of firewood and construction materials for the majority of people.

The total sustainable supply of fuelwood and poles from Malawi's woodlands was estimated at 8.9×10^6 m^3 for 1980, whereas total consumption for that year was estimated at 12×10^6 m^3. The Ministry of Forestry and Natural Resources estimated in 1980 that the potential supply of wood would drop to 5.2×10^6 m^3 by 1990 and to 4.2×10^6 m^3 by the year 2000 because of depletion of standing stock by the rapid expansion of agricultural activities coupled with a high rate of population growth. Some observers see the increasing shortfall as a threat to Malawi's social and economic development and others warn of disastrous environmental consequences.

As the fuelwood shortage grows, people will have to spend more and more time collecting firewood at the expense of other productive farm activities. In some areas, it takes up to 8 hours to gather enough firewood to last 2 or 3 days, and many people now have to pay to be allowed to collect it in protected forest reserves. This is a relatively new experience in Malawi's rural areas where firewood has always been obtained free from natural forests.

The Lilongwe district is one of two areas where a large number of persons have to buy their firewood from the forestry reserve, paying MWK 0.20/bundle or MWK 3.50–4.00 per oxcart load (1 Malawi kwacha [MWK] = 1.15 Canadian dollars [CAD]). Some of those who do this have to leave very early in the morning to be back before dusk. In Mangoche, it takes 5–8 hours to fetch fuelwood and most of the local people pay up to MWK 0.10 to collect a headload from protected woodlands.

Although the problem was recognized as early as the 1940s, it was only in the 1970s that the Government of Malawi began to take steps to increase the wood supply. Among the initiatives taken were the establishment of tree nurseries and fuelwood and pole plantations through the wood-energy program financed by the World Bank, improved extension services, National Tree Planting Day — a public holiday observed on 21 December — and creation of a Wood Energy Division in the Ministry of Forestry and Natural Resources. Apart from the government's own afforestation program, it is now believed that current and future timber and fuelwood demand can be met through small-scale afforestation programs undertaken by the villagers themselves for their own benefit.

The success of all these measures and others that might follow will depend, among other things, on identifying suitable tree species for the country's differing climatic zones, imparting relevant silvicultural management skills to local people, and enlisting their cooperation. The fuelwood and poles research project funded by IDRC was aimed at tackling these and similar problems and was part and parcel of Malawi's efforts to solve the problem of wood shortage.

THE PROJECT

Until the start of the IDRC project in 1978, forestry research efforts had been divorced from the drier, heavily populated areas, most of which were considered geoclimatically difficult. Information on which tree species were suitable for which areas was consequently lacking. Much of the advice provided to the government had been based on sparse test results and relevant information from neighbouring countries. This was considered unsatisfactory and led to the submission of a research proposal to IDRC.

PURPOSE AND PLACE OF RESEARCH

The principal objectives of the project were to identify the best suited, most productive tree species for each silvicultural zone and to involve the local people and determine how best rural communities and individuals could be encouraged and educated to plant trees.

The project was implemented under the auspices of the Forestry Research Institute of Malawi and field operations started in 1978. Although tree planting in the first phase ended in 1981, the government continued to maintain most of the experimental or demonstration woodlots up to the beginning of 1985. By the end of this phase, 93 species trials had been established at 73 research sites. These covered about 200 ha. The trials were spread over seven silvicultural zones in the hope of matching suitable and desirable species with each zone's differing climatic or geoclimatic characteristics. Of the sites, 48 were on communal land, 20 on private land, and 5 on government-controlled forest land. The communal land included several primary schools and agricultural stations.

THE EXPERIMENTAL SITES

The research trials were established in densely populated areas where the natural tree cover is disappearing rapidly and wood for all purposes is becoming or is already scarce. As the involvement and cooperation of the rural public was important to establish and manage small tree plantations jointly, the forestry department was obliged to accept whatever land was offered for tree growing. Except in a few cases, most of the land given was marginal, less than suitable for other crops but good enough for trees.

The plots offered for planting were judged very adequate with regard to access, proximity, typicality of soil, suitability for tree growth, and visibility for extension purposes. Planting techniques were uncomplicated and appropriate, but spacing was a little close for optimum volume production; plot protection was adequate and fire control generally good. Attention to weed control varied more than any other of the plot-maintenance operations observed. Losses attributed to cattle and goats were minimal and fire damage slight. Termites were a significant problem in some areas, with damage varying according to the species of tree. The research highlighted the termite menace and this problem must be taken seriously. Other spoiling factors reported were wind and longhorn beetles. Human interference, such as illicit felling or vandalism was insignificant, and the experimental plots were regarded with considerable respect by the local public — partly because many people still believe that the plots are government property.

PROJECT METHODOLOGY

The methodology used in the afforestation project was fundamentally simple and appropriate. Plots were set up over a wide variety of areas and sites, nationwide, at the same time involving rural communities and individuals and enlisting their cooperation. The first task of the research staff was to acquire land through local leaders and individual farmers. In some areas, this task was relatively easy but, in others, it took a lot of staff time to convince host-cooperants that the government had no intention of taking away their land, which was a common fear.

Certain conventional research criteria had to be relaxed when it came to species selection: "pure" experimentation might have resulted in almost all species failing in some plots. From a research point of view, such failures would still constitute valuable knowledge; however, if none of the species in a plot grow well, the demonstration effect is damaged, as would be the confidence placed in the researchers by the local people, who had been persuaded to volunteer some of their land. Thus, the project tried to balance the search for knowledge against the need to retain the confidence and cooperation of the community by adopting the "best known bet" approach. Mostly potentially successful species were chosen, with relatively few lesser-known or new ones.

Once agreement to use the land had been reached, the forestry department, with the help of local leaders and individual farmers, employed staff who prepared the ground and did the pitting and planting. Care of the plots during the first 3–4 years was in the hands of the forestry department employees. The plots were then handed over to the host-cooperants.

RESULTS

The sound, even inspired, selection of 42 species used in the trials has allowed a clear picture to emerge of which species have the best potential overall, zone by zone. In most of plots visited, most trees have grown impressively well in terms of survival, vigour, form, and potential. Harvesting has begun in a few plots and is reckoned overdue in many others whose owners do not yet fully believe the trees are theirs to take. Some of the good subplots are also being used as a source of seed, not only for research but also for the country-wide wood-energy project funded by the World Bank to the tune of USD 13 million.

Data on the plots, from planting through evaluation of tree performance to harvesting details, are being collected conscientiously and are being transmitted to the Forestry Research Institute. However, information on community involvement and extension has not been obtained as systematically. In any event, valuable information on planting techniques and management of small-scale plantations on communal lands and private holdings has been obtained, and reports are finding their way back to field staff.

Not only has the project identified species that can grow well in different parts of the country, particularly the dry zones, it has also identified six provenances (or sources) of good seed both within and outside the country. Significantly, Malawi's wood-energy project has reportedly made full use of the research findings in using appropriate species and seeds to create plantations and nurseries in wood-deficient areas. Similarly, woodlots have been encouraged in the Lilongwe land development project. Where previously there was a mixture of species, it is now possible to plant the best adapted and most productive.

UTILIZATION

The authors of the report on which this chapter is based visited 32 of the 73 project sites and interviewed key people at each (Nsukwa and Nickerson 1985). The sites selected were representative of all major silvicultural zones, host-cooperants, years when the plots were established, and technical performance of the trees as assessed by the Forestry Research Institute of Malawi. Of the sites evaluated, 16 were communally owned, 8 were private, 7 belonged to institutions, and 1 was on a government forestry reserve.

Project files and reports were reviewed and discussions held with forestry department and research institute officials. More than 100 persons were interviewed, individually or in groups. Plot owners or others working on the sites were knowledgeable enough to supply all the technical information required. Key people such as village chiefs and headmen, individual farmers, and heads of institutions were also questioned and, in places where committees had been formed, their members were among those interviewed.

WITHIN THE PROJECT PLOTS

Harvesting has started at several project sites and is expected at others where the delay stems mostly from the belief that the experimental plots belong to the government and that permission to fell the trees must first be obtained. The forestry department is taking steps, however, to remind people that the trees and the land are theirs.

Seeds have been collected from trees on some demonstration plots and pruned or dead branches have been gathered for firewood. Poles harvested have been used for roofing classrooms and teachers' houses, for building barns, a house, a cattle kraal, a bridge, and a village mosque. Money obtained from the sale of trees harvested has financed a variety of community projects including the expansion of existing woodlots.

BEYOND THE PROJECT PLOTS

Although contact between forestry department research staff and rural communities has been limited, the demonstration effect of the

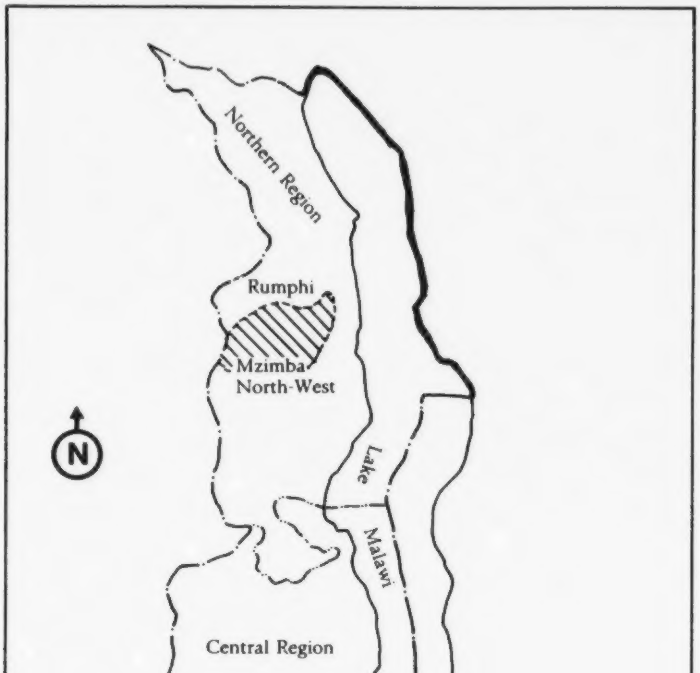

Northern Region
Rumphi
Mzimba North-West
N
Lake Malawi
Central Region
Lilongwe
Mangoche
Bwanje
Southern Region
Phalombe
Nsanje
Evaluation areas
Regional boundary
National boundary
0
50
100
kilometres

Fig. 1. Evaluation areas (shaded) for the *Fuelwood Plantations Project* in Malawi.

experimental plots has been very good. Except in a few cases, the plots are situated where they can easily be seen by members of the local communities. This, coupled with constant stress on the importance of tree planting through extension work, has greatly increased the demand for seedlings, especially in districts where people have to pay to collect firewood. Existing woodlots are being expanded or new ones established in many villages, and new species, such as eucalypts, are being introduced. As well, villagers at many of the project sites have planted a large number of seedlings — usually at the local primary school — on National Tree Planting Day. The main obstacles to tree planting have been termites, drought, livestock, and lack of seedlings.

IMPACT OF THE PROJECT

The impact of this research project in six areas of Malawi (Fig. 1) is summarized in the following paragraphs (findings for each site visited in the follow-up survey are given in the appendix).

In Lilongwe, harvesting has begun at one site and is expected to start soon at five others. The villagers realize the importance of planting trees and a number of them have taken action to that effect. Indeed, the demand for eucalypts has grown so much as a result of the demonstration plots that farmers have not always been able to obtain as many seedlings as they needed. The area is also receptive to the communal woodlot concept and some villages close to the research sites have established their own plantations. Termites and drought are the major constraints to tree planting.

All plots visited in Mzimba North-West and Rumphi are on primary-school land and each school has its own woodlot in addition to the experimental site. Harvesting has started at three of these sites, and the schools have been including *Eucalyptus* trees in their own plots since 1982. A significant number of individuals and neighbouring communities are reported to have planted trees in the past 3 years.

Availability of land is not an important constraint in Bwanje Valley. The main problem here appears to be a lack of adequate forest extension service. Harvesting has started at the three sites visited in Ntcheu but the demonstration effect has been minimal.

The people in Mangoche–Namwera Plains are taking the wood shortage seriously and are keen to participate in the afforestation program although individual holdings are, for the most part, very small. Already several people, either individually or communally, have planted eucalypts after seeing the impressive performance of these trees in the trial plots, but their enthusiasm has been somewhat dampened by termite damage. As they did not have all the necessary inputs used on the experimental sites (fertilizer and insecticide, for example), their trees do not always compare favourably with those in the demonstration plots in terms of survival and growth rate. Nevertheless, the potential for tree planting through communal efforts is high provided a solution can be found to the termite problem. Harvesting has started at two privately owned sites in Mangoche and is keenly awaited at a third in Namwera.

The experimental work in Nsanje was a success despite problems posed by low rainfall and heat. Past attempts by villagers in Nsanje to plant trees have been thwarted by drought and livestock. With the right timing and a good season, heat and drought can be overcome by individuals and communities, but the livestock problem will require a solution involving more than just farmers and villages.

Phalombe Plain is the most densely populated of the areas visited by the authors and one where the wood shortage is most critical. People are, therefore, taking tree planting very seriously and, despite a scarcity of land, a significant number have planted wherever they could in the past 5 years. The establishment of several nurseries in the area through the wood-energy project and the extension efforts of the ministries of Agriculture and Forestry have contributed to the growth of enthusiasm that now exists.

These efforts would certainly not have been so successful on their own without the IDRC-assisted research, which has been able not only to identify suitable tree species but also to demonstrate to the people what they could grow successfully in the area. One farmer, who claimed to have planted 40 000 trees since the 1950s, said he started growing eucalypts only 5 years ago, after the experimental plot had been established on his nephew's land. Another of the trial plots, located at an agricultural station next to a farmers' market, has been a very good training laboratory for farmers. Local leaders said that even if the government decided to increase the price of seedlings, people would still be "struggling to buy them."

In this area, the problem is no longer that of convincing farmers to plant trees but of ensuring that adequate seedlings of the required species are available in sufficient quantities. The other area of concern should be finding ways to deal with the biggest problem that people are facing — termites.

FACTORS CONTRIBUTING TO THE EFFECTIVENESS OF THE PROJECT

The success of so many of the trees grown on the demonstration plots reflects particularly well on early organization and the initial choice of species, which was based on the "best known bet" approach. Moreover, the sites chosen were not only accessible and representative but also highly visible.

Control and maintenance of the sites by the forestry department, the Forestry Research Institute, and host-cooperants has been good and this is reflected in the condition of the many site-suitable tree stands scattered across the country. This has been achieved with the almost sole use of local inputs; for example,

- Sisal hedges and stock guards instead of barbed wire and metal gates;
- Manual cultivation overall instead of tractor plowing and interrow disc-harrowing; and

- Wood ash, euphorbia sap, and cow dung instead of Dieldrin (an insecticide).

The strong institutional support this project has enjoyed, and is still receiving, has been the main factor contributing to its successful implementation. Malawi has an extensive, well trained, and motivated forestry service and the government's commitment to rural afforestation is shown in the ministerial status accorded to forestry, the very substantial wood-energy project (with 88 nurseries projected countrywide), the items devoted to tree planting in the press and on radio, the National Tree Planting Day, research activities, and the professional staff complement of 24 district forest officers plus subordinates. Intersection and interdepartmental cooperation is remarkably good and there is opportunity for early dissemination of plot-derived research findings at the local and area levels for immediate application.

Finally, the authors of the evaluation report list several other specific factors that contributed significantly to the project:

- A constant and conscientious presence, when needed, of skilled and able forest department staff at individual plots from preparation–planting through the period of tree maintenance to the present — that this is very important has been shown in the field: areas that did not have adequate staffing have been less successful in terms of contact with the hosts;
- Provision of adequate transport for field staff because the plots are spread over wide areas;
- Provision of paid labour by the forestry department during the crucial establishment phase but replaced by the plot host with genuine voluntary labour some time (2–4 years) after planting;
- Provision of free seedlings and the necessary fertilizers and insecticide (the former only in some plots), which certainly boosted survival and growth;
- The genuine desire (sometimes after much deliberation) of the various types of host to see some useful trees on their land, and justified faith that the trees and income deriving from them would be theirs alone — in due course; and, not least,
- The inspiration, drive, patience, and dedication of the officers leading the project.

SUMMARY AND CONCLUSIONS

The depletion of the natural tree cover in most areas of Malawi has led to rural households resorting to inferior sources of fuel, such as crop residues, or to people having to travel long distances for fuelwood. This process of tree depletion started a long time ago but has accelerated in the past 10–15 years with an expansion of the agricultural sector that has not been matched with a reasonable program of planting to replace trees cut in the process of clearing land for agriculture.

This rate of deforestation presents a real danger to the local ecology. As pointed out by the World Bank, deterioration in the ecology begins once the rate of timber harvested for all purposes exceeds the

average annual rate of production. This certainly is happening in Malawi: wood consumption for domestic and industrial activities is far ahead of wood replacement.

Since the mid-1970s, the Government of Malawi has taken important steps to increase the supply of wood products so as to halt further deforestation. It has been found necessary to involve farmers in this process by passing laws that require estate owners to devote a certain fraction of their land to tree growing and by encouraging smallholders to plant trees through such schemes as the wood-energy program, the National Tree Planting Day, and the *Fuelwood and Polewood Research Project* financed by IDRC.

The most important constraint that must be overcome is that posed by the ubiquitous termites. Efforts by local people to plant trees are being frustrated by termite damage and, until effective methods of control are found, it will be difficult for local people in most areas to be able to plant gum trees (eucalypts) to any large extent.

Throughout the trial establishment and management, local resources were used. The whole methodology of the research has been simple and appropriate to the situation. Research findings have been constantly fed into the field and applied both in the trials and in other forestry development programs.

The people's attitude to tree planting in the research areas ranges from general awareness of wood shortages with no measures being taken by the local community to one of active promotion of tree planting by local leaders. Attitudes are influenced by the magnitude of the problem and the length of time it has been experienced, extension activities, the ease with which people can obtain seedlings, and the ease with which trees can be grown.

In some areas, particularly Lilongwe and Phalombe, the host-cooperants have shown a keen interest in the trial plots and a significant number of persons in the vicinity are taking tree planting seriously. In such areas, the trial plots have presented an opportunity to the people to learn about various aspects of silviculture and to see that some "impossible" species can be grown successfully with proper management. In Namwera, results are mixed but would be very promising if contact between the forestry department officials and local people could be increased and the problem of termites solved quickly. The same could be said for Mzimba and Rumphi.

In Bwanje Valley, most people do not see the wood shortage as critical: thus, few see the importance of tree planting. More extension work is certainly required in this area. As well, trials here have not been easily accessible to members of the general public either physically or socially. Of all the areas visited, Nsanje presents the greatest difficulty. The general feeling, with few exceptions, is that the problems of livestock and drought are beyond the control of the local community.

Part of the IDRC research project was demonstrating to people in wood-deficient areas that various desirable trees can be artificially established, tended, felled in due course, and used for individual or common good. Overall, judging from the evaluation interviews and authors' observations, this has been achieved, even eminently so where the plots are highly visible. The best example is probably the agricultural station plantation next to the farmers' market in Mpinda. Records here show that sales of tree seedlings from a nearby nursery to 70 local individuals or farmers have, during a recent period, run into tens of thousands. Soon, demonstrations of felling, pole production, and utilization plus ancillary firewood provision (with, in most cases, rapid regrowth) will probably have an even more desirable and galvanizing effect upon the public.

REFERENCE

Msukwa, L.A.H., Nickerson, R.A. 1985. Fuelwood and polewood research project, evaluation report. Centre for Social Research, Malawi. Mimeo.

APPENDIX — FINDINGS OF THE 1985 FOLLOW-UP SURVEY TO 32 PROJECT SITES

LILONGWE — SIX SITES

1. Harvesting has been delayed by the belief that the experimental plot belongs to the government. Two villagers have planted their own trees. A shortage of land appears to be the main obstacle to planting.

2. The committee controlling this communal plot is keen to start harvesting. The trees are expected to be sold at MWK 0.50/pole and the money used to expand the tree plantation and for other village activities. There is keen interest in the plot and in tree planting generally. Some villagers have started their own tree plantations. Neighbouring villages have reportedly established their own woodlots after seeing the research site.

3. Harvesting has started and the produce sold for MWK 83 (CAD 95). Some of the money has been used to finance community activities, the rest is being kept in a village fund to purchase more trees. There is much pride in the demonstration plot and, although individual land holdings in the area are small, people are encouraged to plant trees wherever they can — on the edge of gardens and around houses. A shortage of seedlings appears to be the main obstacle to planting. The whole village is reported to have gone to the primary school to plant trees on the most recent National Tree Planting Day.

4. The plot host awaits government permission to harvest. He plans to sell some of the produce and use the rest to build himself a house. Several individual farmers in the village have planted trees on the edge of their own plots, but seedlings are in short supply. A nearby village established its own woodlot.

5. No trees have been felled because local leaders are uncertain as to the ultimate owner of the plot. There is also some reluctance to expand the plot for fear the government will take over any additional trees. Awareness of the need to plant trees is growing and four villagers have planted trees this year on their own land. The village reportedly planted 300 seedlings on National Tree Planting Day.

6. Harvesting is eagerly awaited. The produce will be sold, with the money going toward the expansion of the village woodlot and other communal activities. A few villagers have planted their own trees.

MZIMBA — THREE SITES

1. The school is waiting for permission to fell the trees and intends to use them to construct new buildings. Three villagers close to the school have started their own woodlots and the school planted its first *Eucalyptus* (gum tree) woodlot in 1982.

2. The school and the village have established their own woodlots and three local farmers are reported to have started their own after seeing the experimental plot. Some 420 seedlings were planted at the school on National Tree Planting Day.

3. A quarter of the plot was harvested in 1984 at the request of the school and 30 poles were used to reroof a classroom block. The others were sold for a total of MWK 28. Although the school has a long history of tree planting, it only introduced blue gum recently and has extended the demonstration plot. The school, led by local leaders, planted 500 seedlings on National Tree Planting Day.

RUMPHI — THREE SITES

1. Once harvesting begins, the trees will be used for roofing teachers' houses and for general maintenance of school buildings. Some trees will be sold for poles and firewood. Six villagers around the school are reported to have planted gum trees after seeing the research site, and a farmers' club has established its own woodlot. Some 200 trees were planted at the school on National Tree Planting Day and 400 were planted later.

2. Harvesting has been limited to seven trees for roofing a teacher's house. Apart from the primary school, the village headman has planted 700 trees this year alone and has established a sizeable woodlot. Two other persons close to the school are reported to have started their own woodlots, consisting mostly of eucalypts. Parents and pupils planted 428 seedlings on National Tree Planting Day.

3. Several individuals and estates in the area are reported to have planted trees after the demonstration plot was established. The major obstacles to planting have been termites and the small size of most holdings.

BWANJE VALLEY — THREE SITES

1. There has been some thinning by the forestry department, with the poles going to the agricultural estate where the research site is located. Seeds have already been collected from some trees and dead branches have been gathered for firewood.

2. Felling has begun in certain subplots consisting of gum trees and the owner of the experimental plot sold the poles to a nearby estate for about MWK 800. Apart from the owner's brother, no one else in the village is reported to have planted trees.

3. Harvesting of gum and cassia trees has started. The produce, valued at MWK 250, is being used on the farm for construction of barns. Several villagers have come to the demonstration plot to take spacing measurements and a neighbouring village has planted 200 seedlings every year for the past 3 years. Damage by livestock has been a problem.

MANGOCHE — FOUR SITES

1. Some trees were harvested in 1984 by the Forest Research Institute with about 95 trees valued at MWK 150 going to the plot host who used them to build a cattle kraal and a house. Dry branches were collected for firewood. Also, the owner planted 100 eucalypts next to his house and all are doing well. Although the villagers envy him, few have taken steps to start their own woodlots.

2. The villagers think the plot belongs to the government, and although they are aware of the need to plant trees, they have been reluctant to do so. The main complaint expressed is that the holdings are not even big enough to grow food, let alone trees.

3. Two subplots of gum trees were harvested and part of the produce — from felling 36 poles — was used to build a bridge and a village mosque. The remaining poles were sold at MWK 1.50 each. Although the people in the area are aware of the need to plant trees, no one is reported to have planted more than 10 seedlings/year. Many believe the experimental plot belongs to the government and are skeptical about the government's intentions.

4. The community believes the research site is purely a government plantation, possibly because it was maintained until recently by paid labour hired by the forestry

department. The village had already established its own communal woodlot and was keen to plant trees but claimed seedlings were in short supply.

NAMWERA — FIVE SITES

1. Although the villagers were told the trees would eventually be handed over to them, they believe the communal research plot belongs to the government. Although past attempts to plant trees were not very encouraging, five villagers have planted blue gums in the past 2 years, and the village would like to try other species next year. The entire village is reported to have planted seedlings at the chief's headquarters on National Tree Planting Day.

2. Local leaders believe that this communal plot belongs to the chief. Another 1048 trees were planted by the villagers after the experimental site was established. Many people have also started planting their own trees and every village is being encouraged to establish its own woodlot.

3. The plot owner intends to use the trees harvested for home building and firewood and to sell the remainder. Five other persons have planted 50 trees each. Termites are the major constraint to success.

4. Five persons are said to have planted trees since the experimental plot was established but termites have reduced survival rates. Local leaders believe that only the government can plant successfully because it has the necessary resources to buy insecticides and fertilizers.

5. There has been no harvesting as the villagers believe the research site is the government's. The village has its own woodlot. One person is reported to have planted eucalypts in 1984.

NSANJE — FIVE SITES

1. Harvesting has not yet started because the village chief is impressed by the demonstration and wishes it to continue. The chief and at least 12 other villagers are reported to have planted trees for firewood and poles.

2. The village chief is pleased with the demonstration plot and frequently inspects it. Harvesting is expected to start in 1986, with the produce to be used mostly for community construction projects and for sale to individuals for home building. The village intends to expand the plot by planting more gum trees but seedlings are not easily available. Some trees were planted at the primary school on National Tree Planting Day.

3. The village chief had no idea when harvesting would begin but indicated the trees would probably be sold to those requiring poles and the money would be put in the village development fund. Local leaders realize the importance of planting trees but are discouraged by drought and damage by livestock.

4. The plot host, who does not fully believe the trees are his, said he would allow the harvest to be used for development self-help projects such as the construction of school buildings. A few people have attempted to plant trees.

5. Proceeds from the sale of trees harvested will be used for community projects. Three persons planted their own trees after seeing the trial plot but drought and goats were a problem. The general view is that if a solution to the livestock problem could be found, people should plant trees individually. Everyone is reported to have participated in the program at the school on National Tree Planting Day.

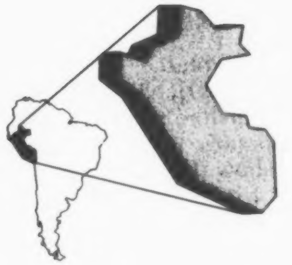
PHALOMBE PLAIN — TWO SITES

The demand for seedlings has greatly increased since 1982 when a local nursery was established in the area.

1. The site is in a forest reserve. It is moderately well established, but the demonstration effect is nil.

2. The gum trees on this plot situated at an agricultural station have been pruned and the lower branches taken for firewood. Because the site is close to a main road, hundreds passing by daily have seen it and the demonstration effect has been enormous. From interviews, observations, and examination of records at the agricultural station, it is apparent that farmers are buying seedlings in the thousands. Indeed, the authors almost went to an individual farmer's plot in the area because it looked so similar to the experimental plot, although this one had only gum trees.

CHAPTER THIRTEEN



STORING SEED POTATOES IN PERU*

In 1977, IDRC provided a grant of CAD 300 000 to the International Potato Center (CIP) in Peru to enable CIP to conduct agroeconomic research on potato production constraints and postharvest technology. More specific objectives were to sensitize CIP and national program scientists to the value of agroeconomic research, to try out agroeconomic procedures such as low-cost farm surveys, and to train national researchers in the use of such techniques. CIP is 1 of the 13 centres sponsored by the Consultative Group on International Agricultural Research that receive their core funding from all the major aid donors. The centres also receive some funding on a project-by-project basis and it is through this channel that IDRC has supported some of their activities. This case study illustrates three important realities about research for development. One is the difficulty and sometimes the limited value of trying to express the impact of some technologies in dollars and cents. Several of the benefits identified in this case, such as reduced risk, are very important to farmers, but hard to quantify. The second reality is that research can be interpreted literally as *re*-search or looking again: it is to do with trying things out and, if they do not work, trying something else. In this case, the major part of IDRC's funding went to a production-constraints thrust, involving testing optimum "packages" of technology. This turned out to be less fruitful than the postharvest thrust that gave rise to the storage developments described in this chapter and to which IDRC's contribution was minor. However, from the process of trial and error and from the contrasting views and approaches of the two thrusts arose useful technology and a more effective approach to research. The third reality is that the farmer is in many respects the key researcher in the process of elaborating technology for agriculture development.

***Material for this chapter was taken from Rhoades et al. (1985), Schmidt et al. (1985), and Horton (1984). Members of the CIP postharvest team were technologists Robert Booth and Roy Shaw and anthropologists Robert Werge and Robert Rhoades.**

INTRODUCTION

Potatoes are produced in 130 countries where 75% of the world's population live. In volume of production (290×10^6 t/year), potatoes rank fourth in the world after wheat, maize, and rice. On a cooked basis, the potato compares well nutritionally with other staples. Peruvian studies show that it can satisfy up to 80% of the dietary nitrogen requirements of infants and small children. The potato is the most important food crop in Peru, grown on 204 000 ha, about 90% in the highlands at 2000 m or more above sea level. Annual production is about 1.6×10^6 t.

Potato storage in Peru has a long tradition. Early Spanish references report the existence of a highly organized storage network in which the state concentrated supplies at strategic centres for consumption nearby. The quantities of goods stored amazed the Spanish, who drew extensively from state warehouses for years. Even in modern times, potato storage has been a major concern. Since the late 1960s, the Peruvian government and various development agencies operating in Peru have sought technical solutions to help control the flow of consumer potatoes into the Lima market. As a result, the Government built five modern storage complexes around the country. Despite technical efficiency and good intentions, these stores and others built in highland areas of Peru today stand empty, just as they have been virtually every day since they were built. The failures resulted because the designers did not fully understand the needs of the existing system of potato storage and marketing as it functions as a whole in Peru.

The storage of potatoes intended for consumption, processing, or planting as seed tubers is an integral part of the potato production process. Particular storage needs are, to a large extent, determined by consumer demand and the magnitude, duration, and frequency of harvests. In other words, potato production and marketing systems, together with demand patterns, determine storage needs and must be fully understood before attempts are made to improve existing storage techniques or to introduce new ones.

The production patterns, and hence storage needs, of potatoes in Peru are complex. In the major producing areas of the highlands, two cropping seasons can be identified: first, early planting on irrigated terrains during June and July (with the harvest taking place in December) and, second, rainfed planting during the main planting season, which begins in September and can be extended until November (with the same farmer planting every month and harvesting from May through July). Cropping patterns, and hence storage needs, are thus very location specific. The minimum period of storage can be as short as 2 months and the maximum, 9 months or more, depending on the characteristics of the production zone.

Although, in contemporary highland Peru, specialized seed producers and complex seed distribution and marketing systems exist, almost all potato farmers try to store part of their last harvest for seed to plant the next year. Home storage is by far the most common manner of keeping potatoes in the Andes. All farmers planting less than 4 ha of land use storage space within the house: it is a convenient and secure place to keep produce. Within the house and the walled compound, potatoes and other assets can be kept from thieves and from the evil eye (*mal de ojo*) of envious neighbours and also will be close at hand for cooking and processing.

Facilities built to store several commodities must involve considerable compromise in design and management to avoid excessive storage losses of individual commodities. Although they are always less effective than buildings constructed specifically for potato storage, such buildings may be the most appropriate and efficient system when the whole farming system is considered. In many potato-producing regions, capital is not available to construct and effectively operate specifically constructed stores. This is one reason for multipurpose storage facilities.

For numerous reasons, many potatoes are sold directly in the field, so those that are brought to the house for storage at harvest time have usually been separated and graded. Tubers destined for seed and those for other purposes are sometimes stored in different parts of the house, although both may be stored under similar conditions.

Many small Andean farmers prefer to store potatoes in the dark, even those to be used later for planting, in case they need to consume the potatoes or to sell them in periods of scarcity: light produces greening in potatoes and renders them unsatisfactory as food. Potatoes are left in piles against the walls of the house and are kept in place by logs, adobe bricks, or stones lined up parallel to the wall. The piles slope up to the wall where they may reach a height of 1–1.5 m.

These traditional storage systems in dark rooms in the house are described by farmers as functional for native potato production on a small scale in the higher zones. In the Mantaro Valley, however, the introduction of new, higher yielding varieties into the lower, warmer production zones forced farmers to confront new technical problems of seed-potato storage. According to farmers, storage in darkness provokes the excessive development of sprouts, which sometimes reach a length of 80 cm, making it necessary to desprout the tubers before planting. The farmers report that an average of 5 person-days is needed to desprout the seed required for 1 ha. Studies by an interdisciplinary postharvest research team made up of technologists and anthropologists from the International Potato Center (CIP) helped to define these farmers' problems and the need for appropriate improved technologies.

Storage problems were not confined to the Mantaro Valley, however. In the coastal areas of Peru, where few refrigerated stores are available, traditional seed-storage practices imported from the highlands resulted in excessive losses and particularly encouraged attack by potato tuber moth. Thus, the need for an appropriate low-cost alternative to the use of controlled low-temperature storage during the hot summer months was identified by coastal farmers and communicated to CIP scientists by collaborating national scientists.

The solution developed by the CIP researchers was the storage of seed potatoes in thin layers in natural diffused light in simple constructions — a solution that appeared to offer multiple benefits over traditional dark-storage methods:

- Seed tubers lose less weight;
- Resistance to pest attacks is higher;
- Yields are higher;
- Conservation is better for a longer period of time; and
- Sprouting is not excessive.

To test the relevance of this "solution," the CIP team then started on-farm testing of the technology. These research trials resulted, in brief, in the continuous simplification of the technology with a view to making it more relevant to resource-poor small farmers without influencing the technical benefits, which were found at the farm level to be similar to those derived at the research station. The technology then appeared ready for diffusion.

Essentially, the process of reaching the Peruvian potato farmers with this potential technology involved two major activities in the initial phases: training and continued on-farm testing, adaptation, and demonstration. Much of the training was conducted with on-farm research units that included previously trained technicians and farmers.

IMPACT OF THE DIFFUSED LIGHT STORAGE TECHNOLOGY

A first follow-up of the dissemination of the diffused light storage (DLS) technology was carried out in 1981 by CIP staff in the Mantaro Valley. At that time, 31 farmers and cooperatives were interviewed and two major conclusions were drawn: the farmers' response to the new technology was positive and no farmer interviewed had abandoned either the trial or demonstration store.

Several had copied the original model proposed, while the rest had understood the diffused light principle and had modified their traditional storage systems accordingly, many making use of corridors or the verandas that are common on farm houses in the Mantaro Valley region (Fig. 1). Several small farmers, for example, combined their new diffused light store with a cage for their guinea pigs and rabbits.

A follow-up visit was also made to coastal cooperatives that had benefited from the on-farm research. In Barranca, the cooperative built a 100-t capacity diffused light store that enabled it to reduce its dependence on highland seed by 50% in 1981. Interviews with managers of the cooperative revealed the following advantages of the improved store:

- Earlier planting and harvesting to avoid *Mosca minadora* (leaf miner fly), the major insect pest on the coast, which causes severe damage later in the season;
- Higher prices by beating the main harvest period;
- Lower costs of production because earlier planting gives rise to earlier emergence, thus minimizing both pest and disease damage and reducing expenditures for pesticides and fungicides;
- Flexibility in that the cooperative can plant as it wishes rather than being dependent on time of arrival of highland seed;
- The *criolla* (local) seed stored in diffused light gave uniform, early emergence; and

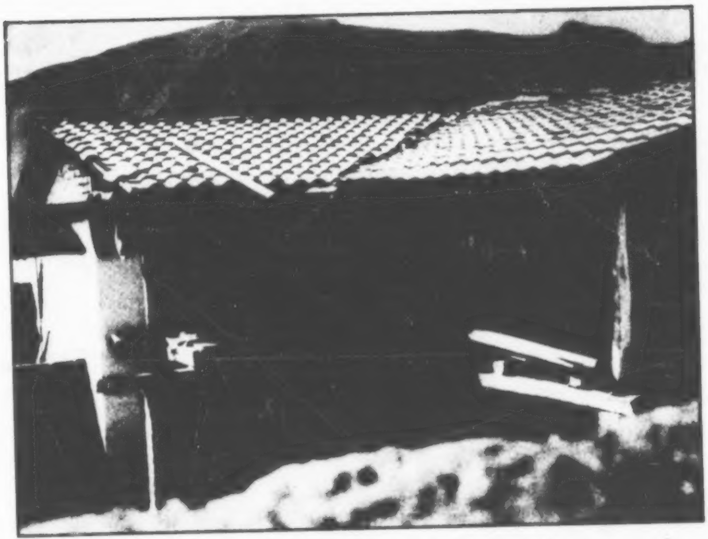


Fig. 1. Diffused light storage of seed potatoes on a second story veranda.

- Seed tubers stored in diffused light were 20% cheaper than "imported" highland seed. This, together with higher market prices as a result of earlier harvest, made the whole operation more profitable.

A further evaluation supported by IDRC was carried out in July 1985 in the Mantaro and Tulumayo valley regions to evaluate the actual levels of adoption of the DLS technique.

ADOPTION

It is evident that, in all places visited, this new technology was being widely disseminated, with "new" farmers continually adopting and adapting the system to their individual needs.

In the study areas where the DLS technology had been introduced by the extension service, the survey team went to every fourth house radiating out from the demonstration stores set up in earlier years. Of 45 farmers surveyed in 1985, 43 were now storing their seed tubers in diffused light and only two continued to store in the dark (Table 1). Of the 43 adopters, 28 had constructed new diffused light stores and 15 had adopted the technology by adapting an existing farm building.

Asked if they knew of anyone else who was using diffused light, the farmers gave the names of 106 other users of the DLS principle.

Farmers' knowledge of the characteristics of the different varieties they cultivate and store is an interesting feature. Seven farmers reported that they did not store all the varieties they cultivated in diffused light due to "lack of space." Two who worked with both native and improved

Table 1. Farm size and type of potato storage used by farmers surveyed.

Cultivated land (ha)	Number of farmers	Diffused light storage		Dark storage
		Separate building	Adapted building[a]	
<1	5	2	2	1
1–5	23	15	7	1
5–10	7	6	1	0
>10	10	5	5	0
Total	45	28	15	2

[a] In corridors, second floors, terraces, sheds, etc.

cultivars continued to store their native varieties in the dark. The other five farmers stored the variety 'Yungay' (a semiearly improved variety with a longer postharvest dormancy period) in the dark, leaving the diffused light store for early varieties such as 'Revolucion', 'Mariva', and 'San Roque' (all improved varieties). Of the 45 farmers interviewed, 4 treated the seed for their early planting differently, leaving it in sacks (even though they have diffused light stores) thus promoting the rapid sprouting of tuber seeds.

These facts illustrate the considerable knowledge that farmers have of their specific needs and how, through their own research and testing efforts, they have been able to adapt the different available storage technologies, including the diffused light technology, to specific requirements prevailing in the particular socioeconomic farm framework.

Although total numbers of adopters in this and other regions is not known, a sense of the growing adoption rate is illustrated by 37 of the 45 farmers surveyed in 1985 who reported when they adopted the use of diffused light. Clearly, transfer of the technology has been increasing

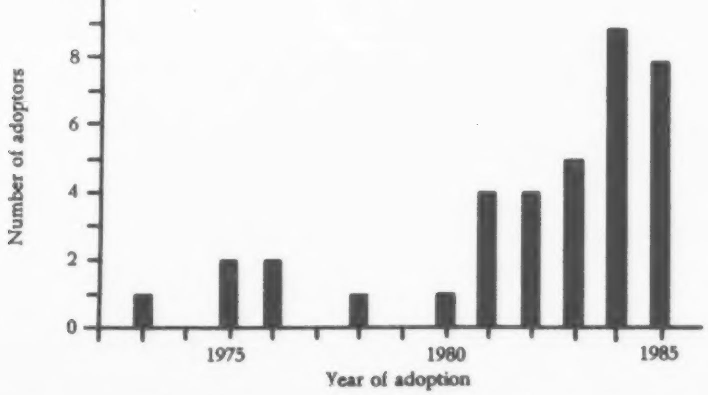


Fig. 2. Number of farmers adopting diffused light storage for seed potatoes (sample of 37) in the Mantaro Valley, Peru, 1973–1985.

progressively over the years (Fig. 2), which suggests that adoption will continue to spread.

Although it is very difficult to verify exact dates of adoption by farmers, the pattern of accelerated adoption is clear, both in Peru and around the world. Research conducted in other countries, such as the Philippines and Sri Lanka, indicates that some farmers were making use of natural diffused light even before CIP started active research on the topic. CIP's research, however, has resulted in a fuller understanding of the technology and, with the collaboration of many national programs, is responsible for the accelerated adoption reported within countries and globally.

As far as the actual adoption process is concerned, two different patterns may be distinguished in the sample surveyed in Peru in 1985.

- Farmers working directly with extensionists from Peru's Instituto Nacional de Investigación y Promoción Agropecuaria (INIPA) tend to progress from storage in complete darkness directly to specially built diffused-light stores.
- Farmers who either attended a course or field day, or saw the rustic seed stores at neighbours' or relatives' houses tended to show more interest in the principle of diffused light than in building exact copies of what they saw, and tended to adapt — with available resources — the most suitable places of their dwellings or other farm buildings.

Farmers have been found using second-floor rooms (such as attics), terraces, sheds, and so on. One farmer took out different roof tiles each time so as to get a uniform greening. Of course, corridors were also commonly used. Diversity of adaptation is due not only to lack of certain materials but, more importantly, to the good understanding of the diffused light principle, which requires only indirect light and good ventilation.

Even though "formal" diffusion takes place somewhat slowly, there are now hundreds of Peruvian farmers exposed to the DLS principle either because they work for bigger farmers who have implemented the technology, or because they are members of cooperatives or communities using diffused light stores, or because they have been reached directly by trained INIPA extension workers.

About 4000 farmers in 16 countries were reported to have adopted the technology by 1984 (Fig. 3), most of them in Colombia, Guatemala, the Philippines, Peru, and Sri Lanka, countries where:

- A need for improved seed-storage practices was correctly diagnosed;
- There is a strong commitment on the part of national scientists to improve seed storage as an integral part of an overall seed-potato program;
- National scientists did not unquestioningly accept the technology from CIP but tested it under local conditions together with local farmers;
- Researchers, extension workers, and farmers cooperated closely in the research testing stage;

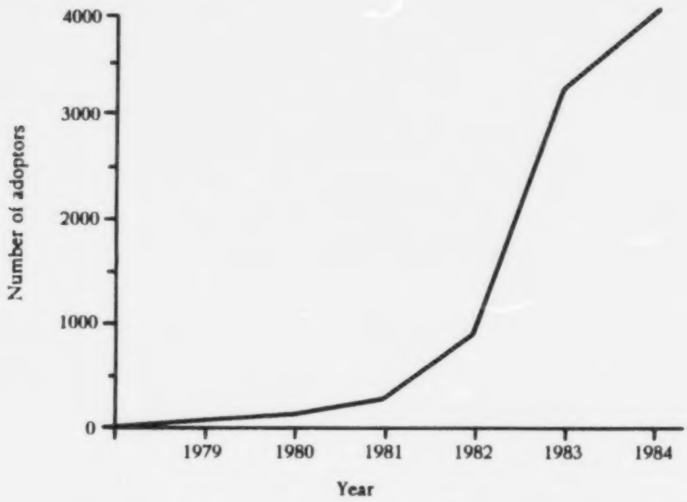


Fig. 3. Adoption of diffused light seed storage in 16 developing countries, 1978–1984.

- Local promoters were knowledgeable about village conditions, had excellent rapport with farmers, and used effective demonstrations that showed a wide range of possible ways of adapting the technology; and
- There was follow-up by scientists and extension workers, especially in the early adoption stage, to refine and improve the technology.

ADAPTATION

Adoption in all countries began with either a few individuals or the community taking the initial risks of experimenting with the "new" technology. Farmers rarely accepted technicians' judgments blindly. All improvements were rarely made at one time. Farmers preferred to make alterations slowly, apparently as they began to understand the principle involved and as they saw the success of their neighbours. The variation of these adaptations ranged from simply spreading potatoes in front of a window to the construction of 100-t capacity stores with natural diffused light.

Farmers' adaptation of the basic principle has meant that in most of these cases, existing farm dwellings or outbuildings were modified. Even when new structures were built, farmers altered the design to meet their own preferences. Worldwide, this principle has been translated into an amazing array of farmers' versions of potato stores, each with a particular cultural flavour. Wherever the idea was introduced through demonstration models, farmers quickly began to experiment on their own. Later, as adoption spread in Peru for example, farmers simply placed a few potatoes under the veranda, an experiment that involved virtually no inputs. Others, either as a first stage of adoption or elaboration of the spreading trial, constructed a raised platform under the veranda, a modification that allowed for better ventilation. Other farmers built simple structures, but few were exact copies of demonstration stores. In fact, CIP and national scientists learned from farmers the potential diversity in forms of adapting and improving the technology to fit their conditions.

BENEFITS

The 1985 survey did not find one farmer who, having tested the new technology, had abandoned the diffused light system. Farmers are very clear about the benefits this new technology offers them (Fig. 4).

This small survey and other experiences with DLS have made it clear that the most important benefit of the technology is to enable the farmer to draw upon good quality seed tubers at planting time, thereby protecting himself from the price increases that always occur as planting time approaches. As well, seed tubers stored in diffused light usually remain suitable for planting longer than those stored in the dark, thus providing extra flexibility and reducing the risk to the farmer. Most farmers do not have the necessary financial resources to be able to purchase fresh seed every year to avoid degenerating yields caused by pests and disease. It is, consequently, a high priority for them to have a low-cost appropriate storage system that will satisfy at least part of their seed requirements for the next crop planting. Also they are more knowledgeable about the real quality of their own seed tubers than those purchased from another farm.

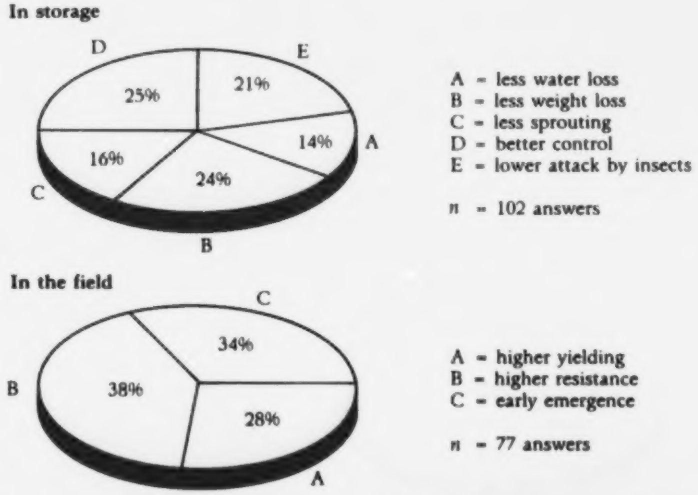


Fig. 4. Perceived benefits of adopting diffused light seed storage. Fewer answers were recorded for "in-the-field benefits" as nine farmers were only planting their first green seed and eight farmers were just in their 1st year of DLS trial.

Finally, as one farmer put it, the system "is worth the effort" although there is certainly more work to do as potatoes must be stored in thin layers on shelves or trays. For these increased efforts, the farmer obtains a healthier and more vigorous seed that does not need to be desprouted, thus saving labour later; has higher yields — between 15 and 30% higher; and has an earlier field emergence.

Monetary measurements of benefits are hard to obtain. There are considerable variations on the cost side: from close to zero to CAD 45/t for simple structures that the farmers estimated would last from 5 to 25 years. Although benefits such as healthier seed, earlier emergence, control over time of planting, and the like can be translated into greater quantity and value of production, no surveys have yet been able to compare measurements of production before and after adoption. In some respects, the high costs that such surveys involve would not add greatly to the stock of useful knowledge. The real experts at benefit–cost analysis are the farmers themselves: only they can weigh up the monetary and nonmonetary implications of a particular experience and decide whether there is a net gain to their lives. So far, almost all farmers who have adopted the DLS technology have continued to use and improve it — fairly solid evidence of development benefits.

CONSTRAINTS

Traditional postharvest food-handling systems in most developing countries have evolved over hundreds or thousands of years. Close examination of a system usually shows that, given the constraints and environmental problems that must be faced, the present system functions, although not always perfectly.

This does not mean, however, that at the level of subsistence farmers there is no room for improvement, but one has to contemplate the risk of changing techniques that have evolved slowly over centuries to meet specific local requirements. Sometimes agriculture in its more traditional form is less risky for farmers.

The knowledge and demonstration of a new technology is, therefore, not alone a sufficient condition for immediate adoption by farmers. In fact, small-scale subsistence farmers invariably face a number of constraints that may not be apparent to the outsider (Fig. 5). Lack of

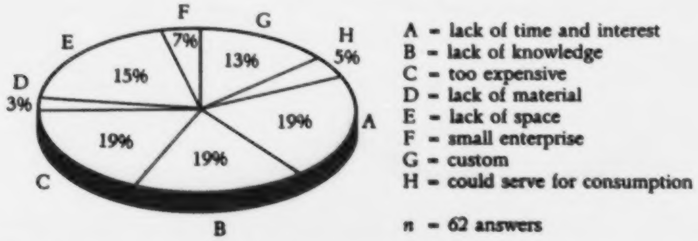


Fig. 5. Reasons given by farmers for nonadoption of diffused light storage by their neighbours and families.

knowledge and interest could be the result of distance, isolation, or inadequate extension services to disseminate the new technology. Although lack of materials, or the funds to purchase them, is an important limiting factor with regard to the more marginal farmers, recommended materials can easily be replaced by other materials available in the region.

Once the technician understands the principles of light and ventilation in the storage of seed potatoes and the farmers are well motivated, "lack of space" should not be a limiting factor in view of the small quantities of seed tubers stored by most Peruvian highland farmers. However, it is clear that a change in the dwelling structure would not be justified if potatoes represented only a small part of the farmer's agricultural activities.

Significantly, although some small farmers were willing to use the DLS technique in cooperative or community stores, the same farmers did not adopt the new approach for their own use where only very small quantities of potatoes were being produced for household use.

The most frequently mentioned constraint has been custom or tradition, but this is not so much resistance to change as it is caution in the face of unproven, and possibly ill-adapted, ideas or techniques. CIP studies in various countries where the DLS technology has been introduced conclude that farmers' traditionalism may be less a barrier than the research and extension systems that are set up to "transfer" technology to farmers.

Perhaps the most significant factor limiting the adoption of DLS is that tubers saved for seed might need to be consumed in periods of scarcity — once "greened" in diffused light, potatoes are not suitable for eating.

Such constraints are not insurmountable, however, given the fact that the technology is very adaptable to specific farmers' needs, and increases their flexibility while reducing risk.

THE RESEARCH PROCESS

CIP's practice of involving social scientists in interdisciplinary teams working on potato production and storage problems illustrates two different approaches to the process of generating technology appropriate for use by small farmers.

The interdisciplinary team (agricultural economist and agronomist) working on problems of constraints to increased potato production adopted an approach initially termed "maximizing potato productivity" but subsequently modified to "optimizing potato productivity." They operated on the assumption that potato farmers' yields and incomes could be significantly increased through better application of existing technology. The team, therefore, aimed to develop and test procedures for identifying constraints in potato production and evaluating alternative technologies under farm conditions. This approach relied heavily on the assumption that appropriate technology already existed and had only to be packaged adequately for the intended beneficiaries. It accepted also that many small-scale farming practices were so rudimentary that a complete package of improved practices was needed to increase yields and economic returns substantially.

Technological packages were used for evaluating recommended technologies under farmers' conditions. In consultation with local production specialists, three packages were designed: a "low-cost package" to increase yields and net returns without increasing costs and financial risks and "medium-cost" and "high-cost" packages to increase yields and net returns more significantly but at higher costs and risks to the farmer. Each of the packages included three recommended practices, the effects of which were believed to be complementary: improved seed, fertilization, and pest control. The levels and costs of these elements varied among the three packages. Performance of the individual elements of the packages was studied in single-factor trials in 1978/79.

The on-farm trials and subsequent evaluation of farmers' adoption in the area revealed four problems with the technological package approach: results were poorer than expected, an optimal package could not be identified, one key element of the packages performed poorly, and farmers did not adopt the packages.

Although the research by the "production-constraints" team was based in major part on ongoing work and staff funded from CIP's core budget, the field work and trials carried out in Peru's Mantaro Valley received substantial support from IDRC. The experience of the team working in the Mantaro Valley made two things clear: first, that there was little "demonstrated technology" that could be transferred directly to farmers without local refinement or adaptive research and, second, that farmers are not passive recipients of recommended technologies but active researchers and developers in their own right.

Although an extension campaign was not conducted within the framework of the *Mantaro Valley Project*, many farmers showed an active interest in the research and began applying some of the practices tested on their farms. A 1982 survey of adoption indicated that very few of the farmers who tested technological packages adopted them, but more than half of the farmers reported taking advantage of one or more of the component technologies. In general, they adapted low-cost practices to fit their specific needs. Very few began using costly certified seed or recommended levels of fertilizers.

This last finding serves to underline the importance of the contrasting approach that was used from the outset by the interdisciplinary team on postharvest problems (anthropologist and agricultural engineer). Their main objective from the outset was to develop simple storage and process technologies appropriate for small-scale farming conditions — although the engineers themselves had earlier tried to test existing technology under small farmers' conditions without notable success.

When postharvest research at CIP began in the early 1970s, the objective was to reduce storage losses by designing structures and systems superior to those present in developing countries. Initial interest centered on farmers living in Peru's Mantaro Valley near the main highland research station. It was assumed at first that heavy "losses" due to rotting, insect attack, shrinkage, and sprouting resulted from the inadequacies of traditional farm storage practices. Projects launched earlier to solve these problems had not been successful and, in 1975, an interdisciplinary team of an anthropologist and biological scientists (in this case storage specialists) was formed at CIP.

By beginning with the farmers and heeding their advice, it became clear that scientists and farmers perceived the storage problem differently. When the anthropologist member of the postharvest team asked farmers about storage "losses," they claimed there were none. They said they used all potatoes in some form. Those that shrank or suffered insect attack and disease, for example, were simply fed to animals, mainly pigs. Additionally, some wives claimed that small, shrivelled potatoes tasted sweeter and were sometimes desired for their culinary quality. There was no waste in the peasant's household economy.

As the biological scientists and the anthropologist dovetailed their efforts, it turned out that there was indeed a real problem. The problem in the farmers' view was that the new varieties of seed potatoes they had adopted in the past decade produced extremely long sprouts and lost considerable weight under traditional storage. The long sprouts had to be pulled off at planting time, a costly process in terms of time and labour. Farmers expressed less concern about problems in the storage of consumer potatoes, the focus of most projects in prior years. Thus the three groups — farmers, biologists, and social scientists — reached common ground. They were now all thinking and talking about the same problem: ways to improve seed-potato storage. CIP shifted the research emphasis toward solving a storage problem emphasized by the farmers themselves: clearly, the conventional approach of controlled low-temperature storage aimed at preventing excessive sprout growth was not appropriate to many of these small farmers.

Fortunately, however, some scientific knowledge already existed indicating that storage of seed potatoes in diffused light (not direct sunlight) would reduce sprout growth, improve seed-tuber quality, and increase yields. On-station experiments with designs for various sizes of store confirmed this, but it was not known how widely applicable or acceptable the diffused light principle would be to farmers or how it could be adapted to specific local storage needs.

The team intensified on-station experiments with diffused light while simultaneously planning on-farm trials to test and adapt developed technologies. The process that followed was one of continuously scaling down the cost and complexity of the first diffused light stores developed and constructed at the CIP research station.

Interaction with farmers had taught the team that a storage structure separate from the family farm dwelling was not realistic because of security problems and convenience. Nor was it realistic to introduce diffused light into the dark traditional stores inside the house because diffused light produced greening in potatoes, rendering them inedible. Fortunately, the inner courtyard of many Mantaro Valley homes features a roofed veranda that permits entrance of indirect light — a perfect opportunity to test the technology under farm conditions.

Although the results of the initial on-farm trials involving the farmer were as positive as those obtained at the experimental station, the seed trays used in the experiments were considered by farmers to be costly and unacceptable. This was the moment of truth for the study. It brought about interaction. The farmer was able to pinpoint the problem, relate it to construction details in the house, and have the ear of the technologists who could easily accomplish the next step of designing simple, collapsable shelves of locally available unworked wood. These were used in a second series of on-farm trials in which the principle of DLS for seed tubers was again successfully demonstrated.

The phase of testing and adapting research was followed by farmer evaluation and adaptation by the farmers. During this stage, farmers themselves, with guidance from cooperating CIP-trained national scientists, began to experiment with and modify the use of diffused light. Follow-up studies revealed that they were not adopting a storage technology per se but adapting the principle of diffused light to their own unique cultural conditions. A "technological package" was not being transferred but rather an idea. Farmers, as researchers, were experimenting with ways to fit the technology into their own socioeconomic reality. The diverse forms of storage techniques and structures using diffused light created by farmers in numerous countries has surprised scientists and illustrates why farmers must assume the role of partner researcher.

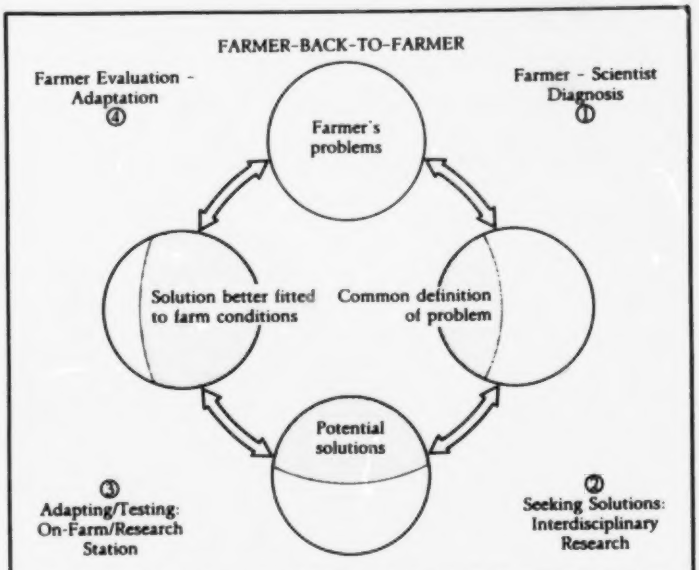
THE FARMER-BACK-TO-FARMER MODEL

The initial experience and experimentation of the postharvest team followed an approach subsequently described as the farmer-back-to-farmer model, a more down-to-earth way of describing farming systems research as it ought to be conducted. Unlike the other models, this approach involves farmers as colleagues and advisors in the research and transfer process. They are full, active members of the problem-solving team.

The underlying assumption of the farmer-back-to-farmer model is that research must begin and end with the farmer. The organization of research is centered around a continuous dialogue between farm and experimental station and among farmers, technologists, extension workers, and social scientists. The farmers enjoy the status of experts on local conditions, soil types, crops, and markets, and it is assumed that they have technical problems for which they seek solutions. This model involves a circular flow of activities, with each aiming to accomplish a goal (Fig. 6).

CONCLUSION

Diffused light storage of seed potatoes is one example of a technology design and transfer process guided by farmers and now adopted by thousands of potato growers in Africa, Asia, and Latin America.


FARMER-BACK-TO-FARMER
Farmer Evaluation - Adaptation
④
Farmer - Scientist Diagnosis
①
Farmer's problems
Solution better fitted to farm conditions
Common definition of problem
Potential solutions
③
Adapting/Testing: On-Farm/Research Station
②
Seeking Solutions: Interdisciplinary Research

The farmer-back-to-farmer model begins and ends with the farmer. It involves four major activities each with a goal. The hatched areas in the circles indicate an increasing understanding of the technological problem area as research progresses. Note that research may constantly re-cycle.

Activities	Goals
1 Diagnosis	Common definition of problem by farmers and scientists
2 Interdisciplinary team research	Identify and develop a potential solution to the problem
3 On-farm testing and adaptation	Better adapt the proposed solution to farmer's conditions
4 Farmer evaluation/adaptation	Modify technology to fit local conditions: understand farmer response

Fig. 6. The farmer-back-to-farmer model for agricultural research (from CIP 1984:111).

Concurrently with the CIP core research activities, and to assist in the testing and transfer of this technology to farmers in other developing countries, cooperative projects with national scientists in many countries were established through CIP's regional research and training network. Cooperative storage research and transfer of technology projects similar to the one discussed in Peru were established in Bolivia, Chile, Colombia, Costa Rica, Ethiopia, French Polynesia, Guatemala, Honduras, India, Kenya, Nepal, the Philippines, Sri Lanka, Thailand, Venezuela, Vietnam, and other countries.

Training became an integral part of the postharvest research and technology transfer program. The specialized training of national scientists using CIP core funding was organized regionally from three potato postharvest research and training centres that were being developed in cooperation with CIP regional and national scientists in Kenya, Peru, and the Philippines, and more recently in Tunisia.

Three years after the interdisciplinary team research began, the principle of using diffused light in rural stores had been introduced through CIP training courses to potato workers in more than 20 countries.

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APPENDIX

ACRONYMS AND ABBREVIATIONS

AGRINTER — Inter-American Information System for the Agricultural Sciences (regional subsystem of AGRIS)[1]
AGRIS — International Information System for Agricultural Sciences Technology (FAO)

BHW — *Barangay* health worker
BRL — Bureau of Research and Laboratories, Philippines

CAD — Canadian dollar
CARE — Cooperative for American Relief Everywhere, Washington, DC, USA
CATIE — Centro Agronómico Tropical de Investigación y Enseñanza (Tropical Agricultural Research and Training Centre), Turrialba, Costa Rica
CDC — Community Development Council, Bo, Sierra Leone
CDD — control of diarrheal diseases
CFC — composite fish culture
CGIAR — Consultative Group on International Agricultural Research, Washington, DC, USA
CIAT — Centro Internacional de Agricultura Tropical (International Centre for Tropical Agriculture), Cali, Colombia
CIDA — Canadian International Development Agency, Ottawa, Canada
CIFRI — Central Inland Fisheries Research Institute, Barrackpore, India
CIMDER — Centro de Investigaciones Multidisciplinarias en Desarrollo Rural (Centre for Interdisciplinary Research in Rural Development), Cali, Colombia
CIMMYT — Centro Internacional de Mejoramiento de Maíz y Trigo (International Centre for Maize and Wheat Improvement), Mexico City, Mexico
CINI — Child in Need Institute, West Bengal
CIP — Centro Internacional de la Papa (International Potato Center), Lima, Peru
CIRB — Centre international de recherche sur le bilinguisme (International Centre for Research on Bilingualism), Ste-Foy, Canada
COLINET — College Libraries Information Network (NJL)
CRIFC — Central Research Institute for Food Crops, Indonesia
CTCRI — Central Tuber Crops Research Institute, Trivandrum, India
CUSO — Canadian University Services Overseas, Ottawa, Canada

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[1] Acronym in parentheses is parent body.

DEVSIS — Development Sciences Information System (IDRC)
DLS — diffused light storage
EAAFRO — East African Agriculture and Forestry Research Organization, Nairobi, Kenya
ECA — United Nations Economic Commission for Africa, Addis Ababa, Ethiopia
EDI — Energy Development International Consultants, Kenya
ERG — Energy Research Group, Ottawa, Canada
FAO — Food and Agriculture Organization of the United Nations, Rome, Italy
FEDESARROLLO — Fundación para la Educación Superior y el Desarrollo (Foundation for Higher Education and Development), Bogota, Colombia
FFDA — fish farming development agencies
FIOCRUZ — Fundação Oswaldo Cruz, Rio de Janiero, Brazil
FSR — farming systems research

GDP — gross domestic product
GNP — gross national product

IARC — International Agricultural Research Centre (CGIAR)
ICAR — Indian Council of Agricultural Research, New Delhi, India
IDB — Inter-American Development Bank, Washington, DC, USA
IDIAP — Instituto de Investigación Agropecuaria de Panamá (Panamanian Institute for Agricultural Research), Panama City, Panama
IDRC — International Development Research Centre, Ottawa, Canada
IEC — Information and Education Communication section, Ministry of Health, Manila, Philippines
IICA — Instituto Interamericano de Cooperación para la Agricultura (Inter-American Institute for Cooperation on Agriculture), San José, Costa Rica
IITA — International Institute of Tropical Agriculture, Ibadan, Nigeria
ILCA — International Livestock Centre for Africa, Addis Ababa, Ethiopia
ILO — International Labour Organisation, Geneva, Switzerland
IMF — International Monetary Fund, Washington, DC, USA
INFOPLAN — regional subsystem of DEVSIS for Latin America and the Caribbean
INIPA — Instituto Nacional de Investigación y Promoción Agropecuaria (National Institute for Agricultural Research and Promotion), Lima, Peru
INTA — Instituto Nacional de Tecnología Agropecuaria (National Institute of Farming Technology), Buenos Aires, Argentina
IRRI — International Rice Research Institute, Los Baños, Philippines
ISIS — Integrated Set of Information Systems (ILO)
ITCO — Instituto de Tierras y Colonización, San José, Costa Rica
ITDG — Intermediate Technology Development Group, London, U.K.

KABALIKAT — Kabalikat ng pamilyang pilipino, Manila, Philippines
KCJ — Kenya ceramic *jiko*
KENGO — Kenya Energy Non-Govermental Organizations Association, Nairobi, Kenya
KREDP — Kenya Renewable Energy Development Project, Ministry of Energy and Regional Development, Nairobi, Kenya

LINET — Legal Information Network (NLJ)

MBPS — milk and beef production systems
MINISIS — Interactive Minicomputer System for Information Retrieval and Library Management (IDRC)
MOH — Ministry of Health, Manila, Philippines

NACOLADS — National Council on Libraries, Archives and Documentation Services, Kingston, Jamaica
NCER — National Centre for Educational Research, Cairo, Egypt
NGO — nongovermental organization
NIC — newly industrialized countries
NLJ — National Library of Jamaica, Kingston, Jamaica
NSERC — Natural Sciences and Engineering Research Council, Ottawa, Canada
NTC — National Training Centre for Rural Development, Bo, Sierra Leone

OAS — Organization of American States, Washington, DC, USA
ODA — official development assistance
OECD — Organisation for Economic Cooperation and Development, Paris, France
ORS — oral rehydration solution
ORT — oral rehydration therapy

PADIS — Pan-African Documentation and Information System, Addis Ababa, Ethiopia
PATH — Program for Appropriate Technology in Health (PIACT)
PHC — primary health care
PIACT — Program for the Introduction and Adaptation of Contraceptive Technology, Seattle, USA
PLAMIRH — Programa Latinoamericano de Investigaciones en Reproducción Humana (Latin American Research Program in Human Reproduction), Bogotá, Colombia
PRL — Prairie Regional Laboratory, National Research Council of Canada, Saskatoon, Canada
PUC — Pontifícia Universidade Católica de Rio de Janeiro, Brazil
PVC — polyvinyl chloride

R&D — research and development
RESADOC — Réseau sahélien d'information et de documentation scientifiques et techniques (Sahelian Scientific and Technical Information and Documentation Network), Bamako, Mali
RIIC — Rural Industries Innovation Centre, Kanye, Botswana
ROCAP — Regional Office for Central America (USAID)

S&T — science and technology
SECIN — Socio-Economic Information Network (NLJ)
SEDP — Socio-Economic Development Program, West Bengal
SIAC — specialized information analysis centre
STD — sexually transmitted diseases
STIN — Science and Technology Information Network (NLJ)

TDR — tropical disease research
TECHNONET ASIA — Asian Network for Industrial Technology Information and Extension, Singapore

UNCSTD — United Nations Conference on Science and Technology for Development, New York, USA
UNDP — United Nations Development Programme, New York, USA
Unesco — United Nations Educational, Scientific and Cultural Organization, Paris, France
UNICEF — United Nations Children's Fund, New York, USA
UNU — United Nations University, Tokyo, Japan
USAID — United States Agency for International Development, Washington, DC, USA
USD — United States dollar
UWI — University of the West Indies, Mona, Jamaica
WHO — World Health Organization, Geneva, Switzerland

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